



**SHAHEED BENAZIR BHUTTO WOMEN  
UNIVERSITY PESHAWAR**

**AGENDA FOR THE MEETING OF SYNDICATE  
DEPARTMENT OF ZOOLOGY**





**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR**  
**DEPARTMENT OF ZOOLOGY**

**Department Curriculum Committee**

- |   |   |   |
|---|---|---|
| 1. _____<br>Dr. Asima Azam<br>Assistant Professor<br>Department of Zoology, SBBWU | 2. _____<br>Dr. Iram Maqsood<br>Assistant Professor<br>Department of Zoology, SBBWU | 3. _____<br>Dr. Sumbal haleem<br>Lecturer<br>Department of Zoology, SBBWU |
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**Curriculum Revamp Committee**

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Dr. Farhat Amin. Associate Professor  
Department of Bioinformatics, SBBWU  
(Convener)

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Ms. Sadia Nazeer (Member)  
Assistant Professor  
Department of English. SBBWU

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Dr. Soofia Iftikhar (Member)  
Assistant Professor  
Department of Statistics, SBBWU

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Dr. Samra Kiran (Member)  
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Ms. Mehwish Asmat Ullah (Member)  
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Quality Enhancement Cell, SBBWU

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Ms. Tashfeen Zia (Member)  
Deputy Director.  
Affiliation and Monitoring, SBBWU

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Dr. Rubi Bilal (Secretary)  
Controller of Examinations, SBBWU

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Dr. Safia Ahmed (T.I)  
Dean Faculty of Sciences & Social Science, SBBWU



# SHAHEED BENAZIR BHUTTO WOMENUNIVERSITY PESHAWAR

## CURRICULUM FOR BS, M. PHIL AND PH.D. ZOOLOGY SESSION 2023 AND ONWARDS

### Approved from the Statutory Bodies

4<sup>th</sup> Meeting of Board of Studies Physical (23<sup>rd</sup> May, 2023) and revised  
by circulation for BS only (October, 2023)

12<sup>th</sup> Meeting of Board of Faculty held on 24<sup>th</sup> October, 2023

19<sup>th</sup> Meeting of Academic Council held on 8<sup>th</sup> November, 2023

Compiled by:  
Dr. Asima Azam (Assistant Professor)  
Incharge, Department of Zoology  
Shaheed Benazir Bhutto Women University, Peshawar

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Enlightenment Through Knowledge



# SHAHEED BENAZIR BHUTTO WOMENUNIVERSITY PESHAWAR

## CURRICULUM FOR BS, M. PHIL AND PH.D. ZOOLOGY SESSION 2023 AND ONWARDS

The faculty of Department of Zoology and the members of board of studies designed the curriculum for BS, M.Phil. and Ph.D. Zoology, developed the framework and scheme of studies, and revised the curriculum in different meetings. The courses were presented and approved in the 4<sup>th</sup> Meeting of Board of Studies Physical (23<sup>rd</sup> May 2023) and revised by circulation for BS only (October, 2023), 12<sup>th</sup> Meeting of BOF (24<sup>th</sup> October, 2023) and 19<sup>th</sup> Meeting of Academic Council (8<sup>th</sup> November, 2023).

| <b>Specializations</b>                           | <b>Faculty</b>                     |
|--|------------------------------------|
| Developmental<br>Biology/Reproductive Physiology | Dr. Asima Azam                     |
| Immunology/Wildlife/Fisher<br>ies                | Dr. Iram Maqsood                   |
| Molecular<br>Biology/Parasitology                | Dr. Sumbal Haleem                  |
| Parasitology                                     | Dr. Fatima Jahan, Ms. Saira Saleem |
| Fisheries & Parasitology                         | Ms. Amber Shaheen                  |
| Entomology                                       | Ms. Asma Akbar                     |



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR  
DEPARTMENT OF ZOOLOGY**

**TABLE OF CONTENTS**

|   |    |
|---|----|
| INTRODUCTION TO THE DEPARTMENT OF ZOOLOGY-----<br>----- | 4  |
| VISION OF THE DEPARTMENT -----<br>-----                 | 4  |
| MISSION OF THE DEPARTMENT-----<br>-----                 | 4  |
| BS (4 YEARS) PROGRAM INTRODUCTION-----<br>-----         | 6  |
| OBJECTIVES OF THE PROGRAM-----<br>-----                 | 6  |
| MISSION OF THE PROGRAM-----<br>-----                    | 6  |
| CAREER OPPERTUNITIES-----<br>-----                      | 7  |
| STRUCTURE-----<br>-----                                 | 8  |
| SCHEME OF STUDIES-----<br>-----                         | 9  |
| DETAILS OF COURSES-----<br>-----                        | 11 |
| LIST OF ELECTIVE COURSES-----<br>-----                  | 44 |

COURSES FOR OTHER DEPARTMENTS-----

67

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## SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR DEPARTMENT OF ZOOLOGY

### **DEPARTMENT INTRODUCTION**

Shaheed Benazir Bhutto Women University Peshawar is a premier women university of Khyber Pakhtunkhwa. It has earned this position by virtue of its futuristic outlook towards higher education, strong emphasis on need-based research and focus on innovation and entrepreneurship. Its academic programs are designed to meet the national needs and challenges of the new millennium. There are several departments working in the university in different disciplines. In the discipline of biological sciences, the department of Zoology was started in 2015. The department was started initially by offering the BS (Hons) and MSC programs. Being a part of one of the leading Women University of Pakistan, the department of Zoology develops the women leaders in the field of teaching as well as research. Zoology as a subject is multidisciplinary in nature, involving study of organisms and their genetic, morphological, and physiological attributes, their surrounding environment, and their role in conservation of environment. Zoology is a combination of various disciplines such as Genetics, Physiology, Ecology, Developmental Biology, Microbiology, Parasitology, Entomology, Freshwater Biology, Fisheries, and Wildlife etc. This subject has significant role in human resources development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty.

### **VISION STATEMENT OF DEPARTMENT**

The main aim of the Department of Zoology is providing quality education and a wide array of programs in the field of Zoology through promoting innovative learning environment for women and to promote and encourage research culture among the students which has relevance to local, **regional**, and national needs.

### **MISSION STATEMENT OF DEPARTMENT**

The mission of the department of zoology is to utilize our knowledge and expertise to train students in zoological science and to equip them with professional skills and ethical practices relevant to zoology to apply them meaningfully in those areas/fields requiring zoological expertise. To create an attractive and research based innovative department where students want to come for study and contributes their role in the welfare of humanity by finding ways to increase the food production, to preserve rare animal species by improving their habitat and to find different zoonotic and other disorders and their solution. The department is committed to achieving academic excellence by pursuing its mission, to produce graduates who will possess the abilities of confident researchers, entrepreneurs, and academicians with sound knowledge.

## **OBJECTIVES OF THE DEPARTMENT**

- To impart quality education of a high level and conduct research in the relevant areas.
- To prepare female students for successful professional careers, in the rapidly changing environments, who will assume the roles of future executive leaders.

## **INTENDED LEARNING OUTCOMES OF THE DEPARTMENT**

- To produce highly competent female graduates, who will contribute to the overall efficiency and effectiveness of organizations.
- To produce high quality female graduate, for assuming the role of executives.
- To provide relevant information to the Public and Private sector organizations, for the improvement of their policies.

## **ELIGIBILITY CRITERIA:**

**BS (4years):** F.Sc. Pre medical/ A-level.

**M.Phil. (2years):** BS (4 Years), M.Sc (2 Years)

**Ph.D.:** M.Phil. (2 Years)



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR**  
**DEPARTMENT OF ZOOLOGY**

**BS (4 YEARS) ZOOLOGY PROGRAM (2023 and onwards)**

**PROGRAM INTRODUCTION**

Zoology as a subject is multidisciplinary in nature, involving study of organisms and their genetic, morphological, and physiological attributes, their surrounding environment, and their role in conservation of environment. Zoology is a combination of various disciplines such as Genetics, Physiology, Ecology, Developmental Biology, Microbiology, Parasitology, Entomology, Evolution, Taxonomy, Freshwater Biology, Fisheries and Wildlife etc. This subject has a significant role in human resource development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty.

**PROGRAM OBJECTIVES**

The program objectives are;

- To impart knowledge about the major disciplines of Zoology and its inter-relationships in the biological systems with reference to animal diversity.
- To adopt a practical approach towards different areas of zoology such as Fisheries, Entomology, Immunology, Reproductive Biology, Genetics and Parasitology.
- To train students for advanced studies and specialization on recently emerging technological and multidisciplinary fields such as Genetic Engineering, Biodiversity, Environmental Science, Wildlife and conservation, Fisheries and aquaculture, Pests and pest management, Biotechnology, etc. After completing the degree / students will be able to apply their knowledge to their respective fields effectively.
- To teach different methods of exploration, investigation, organization of data and its utilization in practical life.
- To get positions in various government and non-governmental organizations, teaching and research, administration and management, aquaculture, fisheries, forestry, agriculture, biological control program, integrated pest management, lab diagnostics, poultry, plant protection, wildlife, livestock, and other areas. To teach different methods of exploration, investigation, organization of data and its utilization in practical life.

**MISSION STATEMENT OF PROGRAM**

The mission of BS Zoology program is;

- To enhance academic excellence by introducing up to date curriculum and impart knowledge about the major disciplines of Zoology.
- To provide different Lab facilities and collaboration with highly reputed research institutions and expertise to prepare the students for professional and practical field. To

provide different Lab facilities and collaboration with highly reputed research institutions and expertise to prepare the students for professional and practical field.

- To equip students with knowledge and skills for better planning and management of animal resources, environment, health, medicine, agriculture, and population in the country.
- To develop the scientific culture and demonstrate professional skills in teaching / research/ managerial positions in wide range of professions in national and international organizations.
- To provide approachable learning to each section of society by grabbing different scholarships opportunities and to produce responsible graduates by educating them ethically.
- To inculcate high values through ethical education and to provide inexpensive educational services to the weaker sections of society.

### **ELIGIBILITY CRITERIA**

Eligibility Criteria for BS:

F.Sc. Premedical/ A level (with Biology)

### **CAREER OPPORTUNITIES**

After obtaining the BS degree in Zoology, the graduates will be able to get jobs in wide range of professions including: Positions in various government and non-governmental organizations, teaching and research, administration and management, aquaculture, fisheries, forestry, agriculture, biological control program, integrated pest management, lab diagnostics, poultry, plant protection, wildlife, livestock, and other areas.

### **PEDAGOGY (TEACHING - LEARNING METHODOLOGIES)**

1. The courses will be delivered through lectures, seminars, practical, discussions and field trips.
2. Teaching learning material will include textbooks, reference books journals/periodicals, handouts, and internet.
3. Using audio/ visual aids i.e., slides/ overhead transparencies / multimedia.

### **ASSESSMENT AND EVALUATION**

Mid-term test

Internal assessment: Seminars and Assignments

Final Examination



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR**  
**DEPARTMENT OF ZOOLOGY**

**STRUCTURE OF B.S ZOOLOGY PROGRAM SESSION 2023 AND ONWARDS**

| <b>Sr<br/>. NO.</b> | <b>Catego<br/>ries</b>                   | <b>Credit<br/>Hours</b> |
|---------------------|--|-------------------------|
| 1.                  | General Education (Gen Edu) Requirements | 34                      |
| 2.                  | Major (Disciplinary) Requirements        | 83                      |
| 3.                  | Interdisciplinary/Allied Requirements    | 13                      |
| 4.                  | Field Experience/Internship              | 03                      |
| 5.                  | Capstone Research Project                | 06                      |
|                     | <b>Total</b>                             | <b>139</b>              |

- Total number of Credit hours 139
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 8
- Course Load per Semester 15-18 Cr hr
- Number of courses per semester 5-7



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR**  
**DEPARTMENT OF ZOOLOGY**

**SCHEME OF STUDIES OF BS -ZOOLOGY 4-YEAR PROGRAM**  
**(SESSION 2023 & onwards)**

| <b>Semester</b>   | <b>Category</b>   | <b>Course Codes</b> | <b>Course Title</b>                                       | <b>Lectures</b> | <b>Lab</b> | <b>Cr. Hrs</b> |
|-------------------|---|---------------------|---|-----------------|------------|----------------|
| <b>Semester 1</b> | Functional English  | ENG-303             | Functional English  | 3               | 0          | 3              |
|                   | Islamic Studies/Religious Studies/Ethics                  | ISL-301             | Islamic Studies/Religious Studies/Ethics                  | 2               | 0          | 2              |
|                   | Arts & Humanities   | XXX                 | Arts & Humanities   | 2               | 0          | 2              |
|                   | Interdisciplinary/Allied                                  | BOT-301             | Plant Diversity   | 2               | 1          | 3              |
|                   | Major-I   | BIT-303             | Cell Biology  | 2               | 1          | 3              |
|                   | Major-II  | ZOL-311             | Diversity of Invertebrates                                | 2               | 1          | 3              |
|                   |   |                     | <b>Total</b>  |                 |            | <b>16</b>      |
| <b>Semester 2</b> | Expository Writing  | ENG-304             | Expository Writing  | 3               | 0          | 3              |
|                   | Ideology and Constitution of Pakistan                     | PST-313             | Ideology and Constitution of Pakistan                     | 2               | 0          | 2              |
|                   | Social Sciences   | XXX                 | Social Sciences   | 2               | 0          | 2              |
|                   | Interdisciplinary/Allied                                  | CHM-300             | General Chemistry   | 2               | 1          | 3              |
|                   | Major-III   | BCHM-302            | Introductory Biochemistry                                 | 2               | 1          | 3              |
|                   | Major-IV  | ZOL-321             | Diversity of Chordates                                    | 2               | 1          | 3              |
|                   |   |                     | <b>Total</b>  |                 |            | <b>17</b>      |
| <b>Semester 3</b> | Quantitative Reasoning (QR I)                             | MTH-401             | Quantitative Reasoning-I                                  | 3               | 0          | 3              |
|                   | Application of Information and Communication Technologies | CSC-308             | Application of Information and Communication Technologies | 2               | 1          | 3              |
|                   | Introduction to Entrepreneurship                          | MS-309              | Introduction To Entrepreneurship                          | 2               | 0          | 2              |
|                   | Natural Sciences  | XXX                 | Natural Sciences (Nutritional psyc)                       | 2               | 1          | 3              |

|   |                                 |           |                                      |              |   |           |
|---|---------------------------------|-----------|--------------------------------------|--------------|---|-----------|
|   |                                 | (HND-512) |                                      |              |   |           |
|   | Major-V                         | BIT-311   | Essentials of Genetics               | 3            | 1 | 4         |
|   | Major-VI                        | ZOL-444   | Animal Form and Function-I           | 2            | 1 | 3         |
|   |                                 |           | <b>Total</b>                         |              |   | <b>18</b> |
| 2+1<br>according miss<br>mehwish<br><b>Semester 4</b> | Quantitative Reasoning (QR II)  | MTH-402   | Quantitative Reasoning-II            | 3            | 0 | 3         |
|   | Civics and Community Engagement | PSC-418   | Civics and Community Engagement      | 2            | 0 | 2         |
|   | Major-VII                       | BIT-413   | Molecular Biology                    | 2            | 1 | 3         |
|   | Major-VIII                      | ZOL-424   | Evolution and Paleontology           | 3            | 0 | 3         |
|   | Major-IX                        | ZOL-425   | Applied Zoology                      | 2            | 1 | 3         |
|   | Major-X                         | ZOL-445   | Animal Form and Function-II          | 2            | 1 | 3         |
|   |                                 |           |                                      | <b>Total</b> |   |           |
| <b>Semester 5</b>                                     | Major-XI                        | ZOL-515   | Animal Behavior                      | 3            | 0 | 3         |
|   | Major-XII                       | MB-314    | Bacteriology and Virology            | 3            | 1 | 4         |
|   | Major-XIII                      | MB-503    | General Immunology                   | 3            | 0 | 3         |
|   | Major-XIV                       | ZOL-555   | Physiology                           | 2            | 1 | 3         |
|   | Interdisciplinary/Allied-III    | BI-401    | Introduction to Bioinformatics       | 2            | 1 | 3         |
|   |                                 |           |                                      | <b>Total</b> |   |           |
| <b>Semester 6</b>                                     | Major-XV                        | ZOL-521   | Biological Techniques                | 3            | 0 | 3         |
|   | Major-XVI                       | ZOL-522   | Research Planning and Report Writing | 3            | 0 | 3         |
|   | Major-XVII                      | ZOL-523   | Animal Ecology                       | 2            | 1 | 3         |
|   | Major-XVII                      | ZOL-525   | Wildlife Conservation and Management | 2            | 1 | 3         |
|   | Major-XIX                       | ZOL-528   | Zoogeography                         | 3            | 0 | 3         |

|                   |                             |         |                                  |                      |   |           |
|-------------------|-----------------------------|---------|----------------------------------|----------------------|---|-----------|
|                   | Interdisciplinary/Allied-IV | BIT-301 | Principles of Biotechnology      | 2                    | 1 | 3         |
|                   |                             |         | <b>Total</b>                     |                      |   | <b>18</b> |
| <b>Semester 7</b> | Internship (Mandatory)      | ZOL-698 | Internship/Field Experience      | 0                    | 3 | 3         |
|                   | Major-XX                    | ZOL-632 | Principles of Animal Systematics | 3                    | 0 | 3         |
|                   | Major-XXI                   | ZOL-633 | Animal Reproductive Biology      | 2                    | 1 | 3         |
|                   | Major-XXII                  | ZOI-634 | Entomology                       | 2                    | 1 | 3         |
|                   | Major-XXIII (Elective)      | ZOL-XXX | Elective-I                       | 3                    | 0 | 3         |
|                   | Capstone Research Project   | ZOL-699 | Capstone Research Project        | 0                    | 3 | 3         |
|                   |                             |         |                                  | <b>Total Cr.Hrs.</b> |   |           |
| <b>Semester 8</b> | Major-XXIV                  | ZOL-641 | Endocrinology                    | 2                    | 1 | 3         |
|                   | Major-XXV                   | ZOL-642 | Developmental Biology            | 3                    | 0 | 3         |
|                   | Major-XXVI                  | ZOL-643 | Parasitology                     | 2                    | 1 | 3         |
|                   | Major-XXVII (Elective)      | ZOL-XXX | Elective-II                      | 2                    | 1 | 3         |
|                   | Capstone Research Project   | ZOL-699 | Capstone Research Project        | 0                    | 3 | 3         |
|                   |                             |         |                                  | <b>Total Cr.Hrs.</b> |   |           |

$$16+17+18+17+16+18+18+15=135$$



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR**  
**DEPARTMENT OF ZOOLOGY**

**DETAILS OF COURSES**

**SEMESTER I**

|   |                             |
|---|-----------------------------|
| <b>Course Title: Functional English</b>       | <b>Course Code: ENG-303</b> |
| <b>Course Structure: Lectures: 3, Labs: 0</b> | <b>Credit hours: 3</b>      |

The content of the course will be taken from the booklet of mandatory and general education courses provided by the university

|  |                                     |
|--|-------------------------------------|
| <b>Course Title: Islamic Studies/Ethics (For non-Muslim Students)</b>  | <b>Course Code: ISL-301/ETH-301</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 0  | <b>Credit hours: 2</b>              |
| The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                                     |

|  |                         |
|--|-------------------------|
| <b>Course Title: Arts &amp; Humanities</b>   | <b>Course Code: XXX</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 0  | <b>Credit hours: 2</b>  |
| The course will be opted from the pool of arts & humanities subjects. The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                         |

|   |                             |
|---|-----------------------------|
| <b>Course Title: Plant Diversity</b>  | <b>Course Code: BOT-301</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit hours: 3</b>      |
| <b>Pre-requisite:</b> None  |                             |
| <p><b>Objectives</b></p> <p>The course aims to:</p> <ul style="list-style-type: none"> <li>• Provide in-depth knowledge of diversity of plants</li> <li>• Study general characters, classification, reproduction and affinities</li> </ul>  |                             |
| <p><b>Course Contents:</b></p> <p><b>Algae</b> (General structure, occurrence, reproduction and classification); <b>Fungi</b> (General structure, occurrence, reproduction and classification, life cycle, economic importance with emphasis on industrial and medicinal significance, Methods of control of pathogenic forms smut and rust); <b>Lichens</b> (General</p> |                             |

account, structure and life history of Physcia); **Bryophyta** (Atracheophyta) (General account, reproduction, classification, affinities and ecological importance with special reference to the life cycle of Anthoceros and Funaria); **Pteridophyta** (General account, structure and life history of Psilotum and its affinities of Psilopsida, Lycopsida, Sphenopsida: General account, structure and life history of equisetum. Pteropsida; Filicinae (Ferns), general account, life history of Adiantum and Marsilea); **Gymnosperms** (General account with reference to structure and life history of Cycas, Pinus and Ephedra and their affinities); **Angiosperms** (Life cycle of a typical angiosperm)

### **PRACTICAL:**

1. Preparation of an inventory of the flora of a given region.
2. To carry on base line study of any designated category.
3. Identification of wild plants used by local communities

### **Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- Identify the diversity of plant
- Know the primary characteristics of plants
- Understand reproduction and life cycle of plants

### **Books Recommended**

1. Bush, M.B., Ecology of a Changing Planet, 3rd Edition, 2020. Prentice Hall.
2. De Klemm, C., Wild plant conservation, IUCN, Gland. 1<sup>st</sup> Ed., 2018.
3. Cornelio Losa, Methods and Techniques in Plant Physiology, 2016, Scitus Academics LLC
4. Cunnighum, A.B, Applied Ethnobotany: People, Wild Plant Use and Conservation (People and Plants International Conservation), 1<sup>st</sup> Ed., 2016, Routledge Publications.
5. Bhattacharya A. and Laxmi V., Methods and Techniques in Plant Physiology, 2015, New India Publishing Company.

6. Dyke, F.V., Conservation Biology: Foundations, Concepts, Applications, 2<sup>nd</sup> ED., 2010, Springer Dordrecht
7. William G. Hopkins, Norman P. A. Hüner. Introduction to Plant Physiology. 4<sup>th</sup> Ed. 2008, Wiley J.
8. Dyke, F.V. 2008. Conservation Biology: Foundations, Concepts, Applications. Springer Science & Business Media
9. Cotton, C.M., Ethnobotany: Principles and Applications 1<sup>st</sup> Ed., Kindle Edition, 2007, Wiley.
10. Grombridge, B. & Jenkins, M. D. World Atlas of Biodiversity: Earths Living Resources in the 21st. Century, University. California Press, Berkeley Physiology. 4th Ed. 2002, Wiley.

|  |                             |
|--|-----------------------------|
| <b>Course Title: Cell Biology</b>  | <b>Course Code: BIT-303</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit hours: 3</b>      |
| <b>Pre-requisite:</b> None   |                             |
| <p><b>Course Objective:</b></p> <p>This course provides the basic concepts of life science,</p> <ul style="list-style-type: none"> <li>• With emphasis on the diversity of life, the physical and chemical nature of living matter, and the form and function of cells and organisms.</li> <li>• Introduce students to the internal organization of the prokaryotic and eukaryotic cell, organelle and membrane function, cell-cell signaling, cell movement, cell adhesion, and the extracellular matrix.</li> </ul>  |                             |
| <p><b>Course Outline:</b> Introduction to cell biology, Form and function of the cell, Types of cells, The Chemical Basis of Life, the chemistry of cell, Cells and organelles overview, The Structure, function, and molecular organization of cellular organelles, Roles of different macromolecules, Enzymes Molecular organization of cells Protoplasm, Cell wall, Cell membrane, transport across membranes, organelles: mitochondria, endoplasmic reticulum, Golgi bodies, plastids, lysosomes, peroxisomes, The Structure and Function of the Plasma Membrane, Cytoplasmic Membrane Systems, cell internal structure,</p> |                             |

cytoskeleton, microtubules, microfilaments, intermediate filaments, structure of chromosomes, Photosynthesis, Components of Photosynthesis, cell division and cell cycle. The key roles of mitosis and meiosis during the life cycle. Compare and contrast different life cycle strategies, focusing on the human life cycle 13 Stages of mitosis and meiosis, Highlighting similarities and differences. Stages of the cell cycle Apoptosis, cell signaling, Cell visualization techniques.

### **PRACTICAL:**

Microscopy and staining techniques; study of prokaryotic, eukaryotic, plant and animal cells; cell structure in the staminal hair of Tradescantia; study of different types of plastids; cellular reproduction; Mitosis: smear/squash preparation of onion roots

### **Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- Acquire the basic concepts of cell biology.
- Understand the metabolic processes of cells in terms of cellular organelles, membranes, and biological molecules.
- Ability to understand the role of macromolecules regulating cellular processes.
- Formulate the critical thinking skills and knowledge on cell.

### **Recommended Books:**

1. Alberts B and Johnson A, 2006. Molecular Biology of the Cell. 4 th Edition; Garland Publishers, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
2. Karp, 2002. Cell and Molecular Biology. 3rd Edition; John Wiley and Sons, New York.
3. Bruce Alberts, Rebecca Heald, Alexander Johnson, Molecular Biology of the Cell 7th Edition, 2022. W.W.Norton and Company.
4. Alberts et al., 2009. Essential Cell Biology. 3rd Edition; Garland Publishers, New York.

5. Thomas D. Pollard, MD, William C. Earnshaw, PhD, FRS, Jennifer Lippincott-Schwartz, PhD and Graham Johnson, Cell Biology, 4th Edition (2023) ISBN : 9780323758000
6. Lodish et al., 2007. Molecular Cell Biology. 6th Edition; Freeman and Company, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
7. Harvey Lodish, Arnold Berk, Chris A. Kaiser- 2016 8<sup>th</sup> Edition Molecular cell biology
8. Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz 2007 2<sup>nd</sup> Edition Cell biology.
9. S C Rastogi 2005 3<sup>rd</sup> Edition, Cell biology. Newage international Publishers.India.

|   |                             |
|---|-----------------------------|
| <b>Course Title: Diversity of Invertebrates</b>   | <b>Course Code: ZOL-311</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: None</b>  |                             |
| <p><b>Course Objective:</b></p> <p>The Objectives of the course are:</p> <ul style="list-style-type: none"> <li>• To impart the basic taxonomic characteristics and classification of all the invertebrate phyla.</li> <li>• To provide understanding of body organization, Feeding and Digestive system; Other Organ System.</li> <li>• To provide the information of their economic and ecological importance.</li> </ul>   |                             |
| <p><b>Course Outline:</b></p> <p><b>Introduction:</b> Brief introduction and Classification of Invertebrates, Evolutionary Relationships and Tree Diagrams: Patterns of organization. <b>Unicellular Life: The Protozoa:</b> Definition, Protozoon classification (up to order level) with Examples. General characteristics; body form and structure, habit, Nutrition in relation to its habitat, respiration; Locomotion (Pseudopodia and Amoeboid Cilia), excretion and role of contractile vacuole. Reproduction, Symbiotic Lifestyles and Evolutionary perspective. <b>Multicellular and Tissue Levels of Organization:</b> Evolutionary Perspective: Origin of Multicellularity. <b>Phylum Porifera:</b> General Characteristics; Habit and its habitat. Body Structure and form; Cell Types, Body Wall, and</p> |                             |

Skeletons. Water canal system and water exchange. Diffusion as force for Nutrition, respiration, and excretion. Reproduction. Importance of porifera for humanity. **Phylum Cnidaria (Coelenterate)**: Characteristics, classification, body organization; diploblastic. Structure and form; body Wall and Nematocysts: its role in nutrition. Habit and habitat. Gastrozoid; digestion, excretion, and Reproduction; Alteration of Generations. Examples: hydra, obelia, physilia etc. **Phylum Ctenophore**: Characteristics, body organization; Diploblastic/Possibly Triploblastic. **Phylum Platyhelminthes**: Evolutionary Perspective; Classification up to order. Body organization; Triploblastic Acoelomate Body Plan. General characteristics. Examples: The Free-Living and parasitic Flatworms, **Phylum Nematode**: Characteristics, body organization. **Phylum Gastrotrich**: Characteristics, body organization. **Phylum Aschelminths**: Evolutionary perspective: Classification up to order. Pseudocoelomate Body Plan. General Characteristics; Feeding and Digestive system; Other Organ System; Reproduction and Development including Phylum **Rotifera**, Phylum **Nematoda** and Phylum **Kinorhyncha**. Some Important Nematode Parasites of Humans. **Phylum Mollusca**: Evolutionary perspective; Relationship to other animals; Origin of the Coelom. Molluscan Characteristics, Classification up to order. The Characteristics of Shell and Associated Structures, Feeding, Digestion, Gas Exchange, Locomotion, Reproduction and Development, and Diversity in Gastropods, Bivalves and Cephalopods. **Phylum Annelida**: Metamerism and Tagmatization, Classification up to Class. External Structure and Locomotion, Feeding and the Digestive system, Gas Exchange and Circulation, Nervous and Sensory Functions, Excretion, Regeneration, Reproduction and Development, in Polychaeta, Oligochaeta and Hirudinea, Further Phylogenetic Consideration. **Phylum Arthropoda**: Evolutionary Perspective: Classification up to Order; Classification and Relationship to other Animals; habit and habitat, Metamerism and Tagmatization; The Exoskeleton; Metamorphosis. **Hexapods and Myriapod**: Evolutionary Perspective: Classification up to class. External Structure and Locomotion, Nutrition and the Digestive system, Gas Exchange, Circulation and Temperature Regulation, Nervous and Sensory Functions, Excretion, Chemical Regulation, Reproduction and Development in Hexapoda, Insects Behavior, Insect and Human. **Phylum Echinoderms**: Evolutionary

Perspective: Relationship to other Animals; Echinoderm Characteristics; **Some Lesser-Known**

**Invertebrates:** The Lophophorates, Entoprocts, Cycliophores, and Cheatognaths.

**PRACTICAL:**

**Note:** Classification of each member of each phylum up to order with adaptations in relation to habitat of the specimen. Preserved Specimen /colored projection slide /CD ROM projection of computer must be used.

1) Study of prepared slides of protozoans: Amoeba, Plasmodium,

Trypanosome and Paramecium as representative of animal like Protists.

2) Study of prepared slides of sponges: spicules of sponges and study of representatives of classes of Phylum Porifera.

3) Study of principal representatives of classes of Phylum Coelenterate.

4) Study of principal representatives of classes of Phylum Platyhelminthes.

5) Study of representatives of phylum Rotifer, Phylum Nematode.

6) Study of principal representatives of classes of Phylum Mollusca.

7) Study of principal representatives of classes of Phylum Annelida.

8) Study of principal representatives of classes of groups of Phylum Arthropoda

9) Study of representatives of classes of phylum Echinodermata.

**Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- Acquire the basic concepts of invertebrates with explanation of evolutionary origin and diversification.
- Understand invertebrate organismal concepts in laboratory and field.
- Demonstrate major evolutionary innovations for invertebrates with functional importance.

- Understand how reproduction and development occurred and able to breed animal in the laboratory/field

**Recommended Books:**

1. Miller, A.S. and Harley, J.B.; 1999, 2002., 2007, 2009, 2012 & 2016. Zoology, 4<sup>th</sup> , 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> , 9<sup>th</sup>& 10<sup>th</sup> Edition (International), Singapore : McGraw Hill.
2. Hickman, C.P., Roberts, L.C/, AND Larson, A., Integrated Principles of Zoology, 15<sup>th</sup> Edition, 2018, (International), Singapore: McGraw Hill.
3. Hickman, C.P., Roberts, L.C/, AND Larson, A., Integrated Principles of Zoology, 12<sup>th</sup>& 13<sup>th</sup> Edition, 2007, (International)Singapore: McGraw Hill.
4. Pechenik, J.A., Biology of Invertebrates, 7<sup>th</sup> Edition, 2015, (International), Singapore: McGraw Hill.
5. Calow, P. (2012). Invertebrate biology: a functional approach. Springer Science & Business Media.

**SEMESTER II**

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|--|-----------------------------|
| <b>Course Title: Expository Writing</b>  | <b>Course Code: ENG-304</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 0  | <b>Credit hours: 3</b>      |
| The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                             |

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|--|-----------------------------|
| <b>Course Title: Ideology and Constitution of Pakistan</b>   | <b>Course Code: PST-313</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 0  | <b>Credit hours: 2</b>      |
| The content of the course will be taken from the booklet of mandatory and mandatory and general education courses provided by the university |                             |

|   |                         |
|---|-------------------------|
| <b>Course Title: Social Sciences</b>  | <b>Course Code: XXX</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 0   | <b>Credit hours: 2</b>  |
| The course will be opted from the pool of social sciences subjects. The content of the course will be |                         |

taken from the booklet of mandatory and general education courses provided by the university

|   |                             |
|---|-----------------------------|
| <b>Course Title: General Chemistry</b>  | <b>Course Code: CHM-300</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 1   | <b>Credit hours: 4</b>      |
| <b>Pre-requisite:</b> None  |                             |
| <b>Course Objective:</b><br><br>The Objectives of the course are: <ul style="list-style-type: none"><li>• Understand and explore the development of the Periodic Table, classify elements based on their electronic configurations in s, p, d, and f orbitals, and analyze group trends and periodic properties such as atomic radii, ionic radii, ionization potential, electron affinities, electronegativities, and redox potential, types of chemical bonding, including ionic, covalent, and metallic bonds. Apply Lewis structures, and molecular orbital theory to predict molecular shapes and bonding in diatomic and polyatomic molecules.</li><li>• Investigate the concepts of acids and bases, including the SHAB concept and the relative strength of acids and bases.</li><li>• Gain introductory knowledge of fundamental principles of thermodynamics, including the zeroth law, first law, and second law. Learn about internal energy, enthalpy, entropy, and Gibbs free energy, major functional groups in organic chemistry and their chemical reactivities.</li></ul> |                             |
| <b>Course Outline:</b><br><br><b>The Periodic Law and Periodicity:</b> Development of Periodic Table; Classification of elements based on s, p, d and f orbitals, group trends and periodic properties in s, p, d and f block elements, i.e., atomic radii, ionic radii, ionization potential, electron affinities, electronegativities and redox potential,<br><b>Principles of Chemical Bonding:</b> Types of chemical bonding; Lewis structures and prediction of shapes   |                             |

using VSEPR model, the localized bond approach: VB theory, hybridization and resonance; the delocalized approach to bonding: molecular orbital theory as applied to diatomic and polyatomic molecules, three center bonds, bonding theory of metals and intermetallic compounds; conductors, insulators and semiconductors; bonding in electron deficient compounds; hydrogen bonding, **Acids and Bases:** Concepts of acids and bases including SHAB concept, relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions. Theory of indicators, solubility, solubility product, common ion effect and their industrial applications, **Thermodynamics:** Thermodynamic system, surrounding, zeroth law of thermodynamics, concept of equilibrium, first law of thermodynamics, concept of internal energy, enthalpy, thermodynamic processes under different conditions (isothermal, adiabatic, reversibility concept), second law of thermodynamics, concept of entropy, Gibb' s free energy, **Chemical Kinetics:** Rate of reactions, order of reactions, molecularity, extent of reaction, rate law, rate laws of zero-order and first-order reactions and differential and integrated forms, examples, concept of half-life and mean-life, factors affecting rates (Arrhenius equation), **Functional Group Chemistry:** A brief introduction to the chemistry of hydrocarbons, alkyl halides, alcohols, phenols, ethers, aldehydes, ketones, amines, and carboxylic acids and their derivatives.

### **PRACTICALS:**

Laboratory Ethics and Safety Measures: Awareness about the toxic nature of chemicals and their handling, cleaning of glassware, safe laboratory operations, Qualitative Analysis: Analysis of four ions (two anions and two cations) from mixture of salts, Qualitative Organic Analysis: Systematic identification of organic compounds (monofunctional and simple bifunctional) and preparation of their derivatives, Determination of heat of neutralization of an acid with a base.

### **Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- Demonstrate a sound grasp of key chemical concepts, including atomic structure, chemical bonding, and stoichiometry.
- Classify elements by orbitals and describing and analyzing group trends and properties like atomic radii, ionization potential, electron affinities, electronegativities, and redox potential.
- Understand hybridization, resonance, localized and delocalized bonding, and the properties of conductors, insulators, semiconductors, and electron-deficient compounds.
- Apply thermodynamic principles to analyze energy changes in various processes and evaluate the factors influencing reaction rates.

**Recommended Books:**

1. Brown, T. Le May, H. Bursten, B. Murphy, C. Woodward, P. Stoltzfus, M. Chemistry: The Central Science (Mastering Chemistry) ed. 14th, Pearson Education, 2017.
2. Chang, R. Goldsby, K. Chemistry ed. 12th, McGraw Hill, 2015.
3. Ebbing, D. Steven D General Chemistry - Standalone book, ed. 11th, Cengage Learning, 2016.
4. Silberberg, M. Amateis, P. Chemistry: The Molecular Nature of Matter and Change, Generic Publisher, 2023.
5. Klein, D. R. Organic Chemistry as a Second Language: Second Semester Topics, ed. 5th Wiley, 2019.
6. Karty, J. Organic Chemistry: Principles and Mechanisms, ed. 2nd, W.W. Norton & Company, 2018.

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|--|------------------------------|
| <b>Course Title: Introductory Biochemistry</b>   | <b>Course Code: BCHM-302</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3</b>       |
| <b>Prerequisites:</b> None   |                              |
| <p><b>Course Objective:</b><br/>This course aims to provide students with</p> <ul style="list-style-type: none"> <li>• Fundamental knowledge of the molecules of life, as well as their function in the context of a living cell.</li> </ul> |                              |

**Course Outline:**

Introduction to biochemistry; water, Ph, buffers, and biochemical composition of cells; carbohydrates – structure and classification; proteins – overview with emphasis on their composition and structure, classification and function; lipids – structure, classification and biological significance; enzymes – properties, nomenclature, classification, and factors affecting enzyme activity including inhibitors and potentiators, basic kinetics, derivation of  $K_m$  and  $V_{max}$ ; coenzymes and vitamins; nucleic acids – structure and function.

**PRACTICAL:**

Preparation of laboratory solutions and Ph determination; qualitative and quantitative tests for carbohydrates, proteins and lipids; enzyme assays and the effect of Ph, temperature and substrate concentration on enzyme activity.

**Course Outcomes:**

At the end of this course students will be able to;

- Identify and classify the various biomolecules.
- Have deep understanding of the function of biomolecules.

**Recommended Books:**

1. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. (2022). *Cell biology E-book*. Elsevier Health Sciences.
2. Murphy, M., Srivastava, R., & Deans, K. (2023). *Clinical Biochemistry-E-Book: An Illustrated Colour Text*. Elsevier Health Sciences.
3. Shanmugam, S., Kumar, T. S., & Panneer Selvam, K. (2019). *Laboratory handbook on biochemistry*. PHI Learning Pvt. Ltd..
4. Satyanarayana, U., & Chakrapani, U. (2020). *Biochemistry, (Updated and Revised Edition)-E-Book*. Elsevier India.
5. Lehninger principle of biochemistry by David L.Nelson and Michael M.Cox, 7<sup>th</sup> latest edition, ISBN-10:1-4641-2611-9, ISBN-13:978-14641-2611-6.
6. *Biochemistry* by Jeremy M. Berg, John L. Tymoczko; Lubert Stryer, ISBN10:1429229365, ISBN-13:97814229229364, Berg, J. M., Tymoczko, J. L., Lubert Stryer. 2010. *Biochemistry*. 7<sup>th</sup> Ed.
7. Lodish, H., Berk, A., Zipursky, S. L., Paul, M., Baltimore D, Darnell, J. 2012. *Molecular Cell Biology*.
8. Nelson, D. L., Cox, M. M. 2012. *Lehninger Principles of Biochemistry*. McMillan Worth Publishers, New York.

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|--|-----------------------------|
| <b>Course Title: Diversity of Chordates</b>      | <b>Course Code: ZOL-321</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1    | <b>Credit Hours: 3</b>      |
| <b>Prerequisites:</b> Diversity of Invertebrates |                             |
| <b>Course Objective:</b>                         |                             |

The Objectives of the course are:

- To enable them to understand the Taxonomic characteristics of Protochordates and chordates.
- To impart knowledge about the phylogenetic relationships of Protochordates and various classes of chordates.
- To develop critical thinking about phylogeny of chordates with respect to their physiological adaptations, behavior and ecology.

**Course Outline:**

**Protochordates:** Classification, Structure, anatomy and organ systems of Acorn worms, Urochordates and Cephalochordates. Reproduction; life histories and metamorphosis of protochordates. Phylogenetic relationships. **Fishes:** Vertebrate Success in aquatic habitat. Phylogenetic relationships of Pisces. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli. Locomotory adaptations, nutrition and digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (*Scoliodon*) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*). **Amphibians:** The first terrestrial vertebrates. Characteristics of amphibians. Phylogenetic relationships. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura. Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona. **Reptiles:** The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles. Phylogenetic considerations. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development of helonia, squamata, Rhynchocephalia and crocodilian. **Birds:** Classification, Feathers, flight and endothermy. Phylogenetic relationships; Ancient

birds and the evolution of flight. Diversity of modern birds. Adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development, Migration and navigation. **Mammals:** Classification, Specialized teeth, endothermy, hair and viviparity. Diversity of Mammals. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

**PRACTICAL:**

- Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.
- Study trip (Visit to PMNH *Pakistan Museum of Natural History*) for the study of diversity of chordates.

**Course Outcomes:**

Upon completion of the course, the student will be able to:

- Acquire the basic knowledge of Taxonomic characteristics of chordates.
- Understand the phylogenetic relations and diversity of Pisces, amphibians, reptiles and mammals.
- Analyze the process of micro evolution within chordates.
- Demonstrate individually the Phylogenetic relationships of chordates and their diversity.

**Recommended Books:**

1. Campbell, N.A., Biology, 9th edition, 2011, Menlo Park, California Benjamin/Cummings Publishing Company, Inc.

2. Miller, S.A. and Harley, J.B., Zoology, 8th Edition 2010, (International) Singapore: McGraw Hill.
3. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14<sup>th</sup> edition (International), 2009, Singapore: McGraw Hill.
4. Dr. Nayan Jyoti Das, Diversity of Chordates, 2020, Mahaveer Publications.
5. Pranveer Singh Chordates: Comparative Account of Physiology, 2015, Nova Science Pub Inc.

### SEMESTER III

|  |                             |
|--|-----------------------------|
| <b>Course Title: Quantitative Reasoning (QR I)</b>   | <b>Course Code: MTH-401</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 0  | <b>Credit hours: 3</b>      |
| The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                             |

|  |                             |
|--|-----------------------------|
| <b>Course Title: Application of Information and Communication Technologies</b>   | <b>Course Code: CSC-308</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit hours: 3</b>      |
| The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                             |

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|--|----------------------------|
| <b>Course Title: Introduction to Entrepreneurship</b>  | <b>Course Code: MS-309</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 0  | <b>Credit hours: 2</b>     |
| The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                            |

|                                       |                         |
|---------------------------------------|-------------------------|
| <b>Course Title: Natural Sciences</b> | <b>Course Code: XXX</b> |
|---------------------------------------|-------------------------|

|   |                        |
|---|------------------------|
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit hours: 3</b> |
| The course will be opted from the pool of Natural Sciences subjects. The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                        |

|   |                             |
|---|-----------------------------|
| <b>Course Name: Essential of Genetics</b>   | <b>Course Code: BIT-311</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 1   | <b>Credit Hours: 4</b>      |
| <b>Prerequisites: None</b>  |                             |
| <p><b>Course Objective:</b></p> <p>This course provides the basic principles of inheritance. Students will gain experience in variety of molecular techniques used in gene analysis. 2. Course will help develop tools aid in the comparison of genetic and genomic data and more generally in the understanding of evolutionary aspects of molecular biology</p>   |                             |
| <p><b>Course Outline:</b></p> <p>Genetics introduction, Patterns and principles of inheritance, Mendelian inheritance, modifications in Mendelian genetics, sex determination and sex-linked inheritance. Genetic linkage and gene mapping. Maternal inheritance and organelles. Physical structure of genes, chromosomes structure and aberrations, tetrad analysis, Probability and pedigrees analysis, transgenes. Polygenic inheritance, Mechanisms of Evolution, Population genetics, epigenetics and genetic variation, Hardy-Weinberg principle.</p> <p><b>PRACTICAL:</b></p> <ol style="list-style-type: none"> <li>1. Determine ABO blood typing.</li> <li>2. Problems solving related to Mendelian inheritance.</li> <li>3. Problems solving in ABO blood typing in Humans</li> <li>4. Problems solving in pedigree analysis</li> </ol> |                             |

**Course Outcomes:**

- This genetics course provides a comprehensive foundation in fundamental genetic principles, from Mendelian inheritance patterns to modifications and exceptions.
- Students will delve into advanced topics such as genetic linkage, gene mapping, and maternal inheritance, gaining insights into chromosomal structures, aberrations, and tetrad analysis.
- The course covers applied aspects, including probability and pedigrees analysis, transgenes, and polygenic inheritance, preparing students to analyze complex genetic traits.

**Recommended Books:**

1. Essentials of Genetics 10th Edition by William Klug , Michael Cummings, Charlotte Spencer, Michael Palladino, Darrell Killian. 2019, Publisher: Pearson, ISBN-13: 978-0134898414
2. Gardner, “Principles of Genetics”, John Wiley and Sons.
3. Griffith et al., “An Introduction to Genetics analysis”, W. H. Freeman. 11 Edition edition (January 12, 2015)
4. James M. and David V. 1997. The Book of Genetics. 2nd Ed.Ser.ELDs Pub.
5. Tortora et al. 2001. Microbiology an introduction. 7 Ed. Benjamin Lumming.

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|--|-----------------------------|
| <b>Course Title: Animal Form and Function-I</b>                | <b>Course Code: ZOL-444</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1                  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: None</b>                                     |                             |
| <b>Course Objective:</b><br>The Objectives of the courses are: |                             |

- To teach about animals' diversity adapted in different strategies for performance of their similar functions through modifications in body parts in past and present times.
- To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.
- To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.

**Course Outline:**

**Protection, Support, and Movement:** Protection: the integumentary system of invertebrates and vertebrates; Movement and support: the skeletal system of invertebrates and vertebrates; Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates. **Communication I:** Nerves: Neurons: structure and function. **Communication II:** Senses: Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygrometers, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates. Lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates. **Communication III:** The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action. Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemertean, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals. **Circulation and Immunity:** Internal transport and circulatory systems in invertebrates. Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells. transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response.

**PRACTICAL:**

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study of endocrine system in an insect and a rabbit.
3. Study and notes of skeleton of Labeo (Labeo rohita), Frog (Hoplobatrachus tigerinus), Varanus (Varanus bengalensis), fowl(Gallus gallus domesticus) and rabbit (Oryctolagus cuniculus).
4. Note: Exercises of notes on the adaptations of skeletons to their function must be done.
5. Earthworm or leech; cockroach, freshwater mussel, Channa or Catlacatla or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.
6. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

**Course Outcomes:**

Upon completion of this course, the students should be able to:

- Acquire the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in t environments e.g. gills in aquatic and lungs in terrestrial environment.
- Understand that diverse forms adapted to perform the same functions are because of the different past and present conditions.
- Solve of emergence of diversity of forms for the performance of similar function.

**Recommended Books:**

1. Edward Stuart Russell, Animal Form and Function-I, 2015, Palala Press.
2. Hickman, C.P., Roberts, L.S., & Larson, A. Integrated principle of Zoology, 17<sup>th</sup> edition, 2017, (International) Singapore: McGraw Hill.
3. Pechenik, J.A. Biology of Invertebrates, 4th Edition, 2013, (International), Singapore: McGraw-Hill.

4. Hickman, C.P., Roberts, L.S., Larson, A., Integrated Principles of Zoology, 11<sup>th</sup> edition, 2004, (International), Singapore: McGraw-Hill.

## SEMESTER IV

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|--|-----------------------------|
| <b>Course Title: Quantitative Reasoning (QR II)</b>  | <b>Course Code: MTH-402</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 0  | <b>Credit hours: 3</b>      |
| The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                             |

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|--|-----------------------------|
| <b>Course Title: Civics and Community Engagement</b>   | <b>Course Code: PSC-418</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 0  | <b>Credit hours: 2</b>      |
| The content of the course will be taken from the booklet of mandatory and general education courses provided by the university |                             |

|   |                             |
|---|-----------------------------|
| <b>Course Name: Molecular Biology</b>   | <b>Course Code: BIT-413</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3</b>      |
| <b>Prerequisites:</b> Biochemistry I  |                             |
| <p><b>Course Objectives</b></p> <ol style="list-style-type: none"> <li>1. To study classical and molecular aspects of cell.</li> <li>2. The course emphasizes about the chromosome structure, transfers of genetic information, gene expression and regulation of gene activity.</li> <li>3. The course is basis for structural biology, it aids in the simulation and modeling of DNA, RNA, and protein structures as well as molecular interactions.</li> </ol> |                             |

### **Course Outline**

Introduction to Molecular Biology. Basic concepts about DNA, RNA and proteins with special emphasis on nature of genetic material and its organization in viruses, prokaryotes and eukaryotes, Structure function and replication of DNA, DNA as Heritable material structure of DNA, Chromatin and Chromosome organization: physical structure of genes. Gene Expression Genetic Code, Codon, Anticodon, Ribosome, Translation, Gene Expression in Prokaryotes, the lac operon, Gene Expression in eukaryotes, Molecular Basis of Mutation Basis of mutation. DNA damage, DNA Repair Recombination. Types of mutations. Replication errors and their repairs: DNA repair – Single step and multistep: RNA processing, splicing and editing, translation and post-translational modifications, Regulation of gene expression in prokaryotes and eukaryotes. Introduction about plasmids and vectors. Recombinant DNA Technology, CRISPR/CAS9-Targeted Genome Editing. Molecular evolution; DNA based phylogenetic trees and their applications.

### **Course Outcomes:**

1. Equip students with a comprehensive understanding of molecular biology.
2. Preparing them for careers in research, biotechnology, and various fields where molecular biology principles are applied.

**Lab Outline:** Isolation of DNA from plant cells, Protocols for isolation of DNA from blood. Protocols for Amplification of DNA by PCR. Gel Electrophoresis.

### **Recommended Books:**

1. David M. P. Academic Press London, Methods in Cell Biology Lowery Sekivetz. Cell Structure and Function. John Willey and Sons Publication. 3 edition (October 7, 2011).
2. Jordanka Zlatanova. Molecular Biology: Structure and Dynamics of Genomes and Proteomes 2nd Edition Garland Science ISBN-13: 978-0367678098 April 21, 2023
3. Gerald Karp - Cell and molecular biology concepts and experiments - Hoboken, NJ - John Wiley - 2010 - 5th Ed.

4. Brown T. A. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, 2010
5. Robert Weaver. Molecular Biology. McGraw Hill, 5<sup>th</sup> Edition, 2007.
6. James D. Watson, Tania A. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, Pearson, 7th Edition. 2014.

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|--|-----------------------------|
| <b>Course Title: Evolution and Paleontology</b>  | <b>Course Code: ZOL-424</b> |
| <b>Course Structure: Lectures: 3, Labs: 0</b>  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: None</b>   |                             |
| <p><b>Course Objective:</b></p> <p>The Objectives of the course are:</p> <ul style="list-style-type: none"> <li>• Provide in-depth knowledge of origin of life.</li> <li>• Develop concepts about forces responsible for evolutionary changes.</li> <li>• To determine the significance of systematics in relation to their nomenclature.</li> <li>• To provide information on the distribution of animals and their associations in the past and to rationalize their relationship in the present time.</li> </ul>  |                             |
| <p><b>Course Outline:</b></p> <p><b>Introduction to Evolution:</b> Origin of Earth, Origin of Life, theories of origin of life, Life on another planets. <b>Evidences of Evolution:</b> Homology and Analogy, Evidences from comparative anatomy, Vestigial organs, Connecting Links, Atavism / Reversion, Evidences from Comparative Embryology, Evidences from comparative physiology and biochemistry, Evidences from cytology, Evidences from paleontology, Evidences from taxonomy. <b>Darwinism:</b> Theory, Evidences, Criticism, Examples. <b>Lamarckism:</b> Theory, Evidences, Criticism, Examples. <b>Sexual Selection:</b> Main Points, Examples, Criticism. <b>Microevolution:</b> Factors initiating elementary evolutionary changes, (Micro-evolution) by</p> |                             |

changing gene frequencies, mutation pressure, Selection pressure, immigration and crossbreeding, Genetic drift, Animal Migration, Role of isolation in evolution, Allometry, orthogenesis, adaptive radiation, Gene Pool, Fisher's view, Zahavi's handicap theory, Recapitulation theory. **Coloration and mimicry:** Types of important colors, chromatophores, types of mimicry. **Introduction to Paleontology:** The Planet Earth: History, Age and shells of earth, Sphere of Earth, Atmosphere, hydrosphere, Biosphere and lithosphere. **What are Rocks:** types; Igneous rocks, sedimentary rocks and metamorphic rocks, Fossil, different types of fossils, Uses of fossils, nature of fossils, Fossilization, Geological time scale. Evolutionary history of man, elephant, horse and camel.

### **Course Outcomes:**

On completion of this course, the students should be able to:

- To acquire basic knowledge for the factors and theories related to the origin of life and processes involved in the fossilization of animals.
- Develop the understanding of speciation, dispersal isolation and extinction process through biogeography and fossils record.
- Establish understanding regarding process of fossilization and its importance in evolutionary history of an animal and its distribution.
- To illustrate the ability to locate, characterize and differentiate various biomes and fossils of animals over time.

### **Recommended Books:**

1. Traulsen, A., & Glynatsi, N. E., The future of theoretical evolutionary game theory. Philosophical transactions of the Royal Society of London, 2023, Series B, Biological sciences.
2. Adler, I. K., Fiedler, D., & Harms, U., Darwin's tales-A content analysis of how evolution is presented in children's books, 2022, PloS one.
3. Hancock, Z. B., Lehmborg, E. S., & Bradburd, G. S., Neo-darwinism still haunts evolutionary theory:

A modern perspective on Charles worth, Evolution, 2021, international journal of organic evolution.

4. Charles worth, B., & Charles worth, D., Evolution: A very short Introduction, 2017, Oxford University Press.
5. Strickberger. M.W., Evolution. 2012, Jones & Barrett Publishers.

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|--|-----------------------------|
| <b>Course Title: Applied Zoology</b>   | <b>Course Code: ZOL-425</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: None</b>   |                             |
| <b>Course Objective:</b><br><br>The objectives of the course are: - <ul style="list-style-type: none"><li>· To transfer knowledge about the economic importance of animals, their various diseases, commercial value and their by-products.</li><li>· To teach the importance of human and domestic animal diseases and their vital relation to the economy.</li><li>· To provide knowledge about internal and external parasites and their effects on domestic animals and their farming practices</li></ul>  |                             |
| <b>Course Outline:</b><br><br><b>Aquaculture: Fish culture,</b> Types of cultural fishes, Types of fish culture, Factors affecting fish culture, Construction of fish pond, Types of fish ponds, Steps of fish culturing, Fish by-products. <b>Modern fish farming techniques</b> -The module deals with different types of Modern fish farming techniques like aquaponics, RAS, Biofloc, aquascaping. The module also deals with culture of aquarium plants. <b>Integrated fish farming:</b> The module deals with different ypes of integrated farming. <b>Apiculture,</b> History, Species of honey bee, Social organization of honey bee, Life history, Methods of bee keeping, Products of bee keeping, Diseases of honey bees. <b>Sericulture:</b> Sericulture- Sericulture-the technique of |                             |

silk production, life cycle, types of silk and silk insects, different types of silk worm, the culture technique and economic importance, role in economy, silkworm diseases. **Lac Culture:** Biology and life of LAC insect, Rearing of lac insects / cultivation of lac, Processing of LAC, Predators and parasites of LAC insect. **Zoonotic Disease:** Zoonotic Diseases. **Insect vectors-** Mosquitoes, Anopheles, Culex, Aedes and Xenopsylla-(Mosquitoes like Aedes and females of Anophelus, Culex that act as vectors for yellow fever, chikungunya; malaria and filariasis. Xenopsylla (rat flea) serve as vectors of pasteurilla and rickettsia. Life cycle, pathogenicity, control is explained, Insect control - Natural, cultural, mechanical and physical control methods. **Biological control & Integrated Pest Management Control** of vectors using their natural enemies, mostly predators, such as bacteria, plants and fishes is explained. **Poultry farming:** Introduction, Importance of egg production, Nutritive value of eggs. Poultry breeds (Indigenous breeds- & Exotic breeds), Significance of Poultry eggs and meat. **Cattle farming:** introduction and Biology of cattle's, cattle farming, Cattle breeds (Dairy breeds, Draught breed, Dual purpose breed, Exotic breed, Native breeds.

#### **PRACTICAL:**

1. Study of pond and visit to fish pond site.
2. Study of honey comb and different types of bees, different life stages of honey bees
3. Study of different diseases
4. Study Visit of Poultry farm · Study Visit of dairy farm
5. Collection of insect vectors

#### **Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- ACQUIRE basic knowledge of Commerce and Economics in relation to Zoology
- UNDERSTAND the Economic relationship of Animals with Humans
- SOLVE problems related to animal husbandry and pest management by applying theoretical

knowledge with practical efficacy

- ANALYZE and enhance Animal husbandry techniques by using different Entrepreneurship skills
- DEMONSTRATE the Economy based interactions of Man and Animals

**Recommended Books:**

1. Akhtar, M. and Muzaffar, N., Introduction to Apiculture, Department of Zoology, 2008, Punjab University Press.
2. An Introduction to Economic Zoology by Kalim Ullah and Atta ullah. 2022.
3. AN Arumugam, T Murugan, R Ram Prabhu J., Johnson Rajeshwar, Applied Zoology, 2015, Saras, Publication.
4. Goswami Rachna Kumar Dinesh Deshmukh Nazneen Z. Rathoure Ashok K., Applied and Economic Zoology, new edition, 2015, Published by Astral International.
5. Dr. Ajay D. Patil, Vitthal A. Jadhav, Applied Zoology - I, latest edition, 2014.

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|--|-----------------------------|
| <b>Course Title: Animal Form and Function-II</b>   | <b>Course Code: ZOL-445</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites:</b> Animal Form and Function-I   |                             |
| <b>Course Objective:</b><br>The Objectives of the courses are: <ul style="list-style-type: none"><li>• To teach about animals' diversity adapted in different strategies for performance of their similar functions through modifications in body parts in past and present times.</li><li>• To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.</li></ul> |                             |

- To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.

### **Course Outline:**

**Nutrition and Digestion:** Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion. Animal strategies for getting and using food, diversity in digestive structures of invertebrates. The mammalian digestive system: gastrointestinal motility and its control. Oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion. **Temperature and Body Fluid Regulation:** Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals; Heat Production in Birds and Mammals. Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate. Excretory Systems; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions. **Reproduction and Development.** **Reproduction:** Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction; Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes; The human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function; The human female reproductive system: folliculo genesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation.

### **PRACTICAL:**

- Study of excretory system in an invertebrate and a vertebrate representative (Model).
- Study of dissection system in invertebrate and a vertebrate representative (Dissection).
- Dissection and study of male and female reproductive system in vertebrates and invertebrates.

Note: Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used.

**Course Outcomes:**

- Acquire the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in t environments e.g. gills in aquatic and lungs in terrestrial environment.
- Understand that diverse forms adapted to perform the same functions are because of the different past and present conditions.
- Solve of emergence of diversity of forms for the performance of similar function.
- Analyze the requirements of diverse forms for the performance of similar function in their past and present needs.

**Recommended Books:**

1. Hickman, C.P., Roberts, L.S., & Larson, A., Integrated principle of Zoology, 17<sup>th</sup> edition, 2017, (International) Singapore:McGraw Hill.
2. Pechenik, J.A. Biology of Invertebrates, 4<sup>th</sup> Edition, 2013, (International),Singapore: McGraw-Hill.
3. Cleveland Hickman, Jr., Susan Keen, Allan Larson, David Eisenhour, Integrated Principles of Zoology, 15<sup>th</sup> edition, McGraw-Hill Science/Engineering/Math.
4. Miller, S.A., Harley, J.B. 2016. Zoology, 10th Ed. (International),Singapore: McGraw-Hill.
5. Patri M., Comparative Anatomy of Vertebrates, latest edition, 2017, NewYork: McGraw-Hill.

**SEMESTER V**

**Course Title: Animal behavior**

**Course Code: ZOL-515**

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|--|------------------------|
| <b>Course Structure:</b> Lectures: 3, Labs: 0  | <b>Credit Hours: 3</b> |
| <b>Prerequisites: None</b>   |                        |
| <p><b>Course Objective:</b></p> <p>The Objectives of the course are:</p> <ul style="list-style-type: none"> <li>• To impart knowledge about animal responses to external stimuli</li> <li>• To emphasize different behavioral mechanisms (classical and recent concepts).</li> <li>• To explain development of behavior with suitable examples of animals.</li> <li>• To understand the role of genetic and neurophysiology in behavioral development.</li> </ul>  |                        |
| <p><b>Course Outline:</b></p> <p><b>Introduction, Behavior</b>, and its types. <b>Proximate</b> and <b>ultimate</b> causes of behavior. <b>Development of behavior</b> and impact of neural and physiological mechanisms; role of external and internal stimuli and animal responses. Physiology of behavior in changed environments. <b>Hormones</b> and behavior in animals. <b>Innate behavior and innate releasing mechanisms</b>; built in programmed performance by offspring to that of parents. Innate behavior of three spined stickle back fish. <b>Learned behavior</b> and its mechanisms, quick learners' vs slow learners. Concept of animal cognition; key to understand and develop multiple behavioral choices. Ecological and genetics to maintain animal behavior. Concept of territoriality and defense in animals. <b>Circadian rhythms</b> and concept of <b>bio-rhythmicity</b> in animals. Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities. <b>Costs and benefit ratios</b> in behavior; successful foragers and winners of predator-prey relationships. Altruism and parental sacrifice to nurture the young. <b>Competition for resources</b>; survival of the most suitable individuals; evolutionary arms races in behavior. <b>Social organization</b> in animals and concept of group living; benefits and losses. Aggression, appeasement, and selfish individuals. Social organization in insects and mammals. <b>Communication in animals</b>: Visual, Bioacoustics, electrical, chemical, and tactile. Various types of <b>chemical signals in animals'</b> behavior and their importance in ecosystems.</p> |                        |

**Course Outcomes:**

Upon completion of this course, the students should be able to:

- Outline the baseline information and knowledge for animal behavior.
- Associate the role of external and internal stimuli on various animals during the day, season, and year.
- Relate daily behavioral rhythms in diurnal and nocturnal periodicities.
- Predict and anticipate variety of animal actions (costs and benefits) as assessed by innate and learned behavioral displays.

**Recommended Books:**

1. A Textbook of Animal Behaviour-Gundevia, 2016,
2. Dngatkin, L. A., Principles of Animal Behavior, 2012, W.W. Nortan and Co. New York.
3. Alcock, J, Animal behavior; an evolutionary approach, 9<sup>th</sup> edition, 2010, Sinauer Publishers
4. Michael D. Breed, Janice Moore, Animal Behavior, 2<sup>nd</sup> edition, 2015, academic Press.
5. Gundevia H. S., Animal Behavior, 1<sup>st</sup> edition, 2016, Publisher: S Chand & Co Ltd.

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|---|----------------------------|
| <b>Course Title: Bacteriology and Virology</b>  | <b>Course Code: MB-314</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit hours: 3</b>     |
| <b>Pre-requisite:</b> None  |                            |
| <b>Course Objective:</b><br><p>The Objectives of the course are:</p> <ul style="list-style-type: none"> <li>• To provide a comprehensive understanding of bacteriology, virology, and their significance in various fields.</li> <li>• To equip students with practical laboratory skills for working with microorganisms.</li> <li>• To explore the latest research and developments in the field of microbiology.</li> <li>• To foster critical thinking and problem-solving skills related to microbial interactions and disease control.</li> </ul> |                            |

**Course Outline:**

Introduction to Microorganisms. Bacterial Morphology, Growth and Reproduction. Bacterial taxonomy and nomenclature, basis of classification of bacteria. General methods of studying microorganisms: Cultivation, isolation, purification, characterization, and preservation. Control of microorganisms by physical and chemical methods. Chemotherapeutic agents and antibiotics. Modes of action of antibiotics on microorganisms. Host-Pathogen Interactions. Mechanisms of Bacterial Infections. Application in various modern sciences especially agriculture, biotechnology and genetic engineering. Introduction to Viruses. Nature of Plant, animal & Bacteria viruses. Structure and Classification of Viruses. Viral Replication and Assembly. Virus-Host Cell Recognition. Antiviral Strategies. Vaccines and Antiviral Agents. Emerging Viral Diseases

**PRACTICAL:**

1. Methods of sterilization of glassware and media etc.
2. Preparation of different bacterial media.
3. Preparation of slides for the study of various forms, capsule/slime layer, spores and flagella
4. Gram staining.
5. Growth of bacteria, sub-culturing, and identification of bacteria on morphological and biochemical basis (using available techniques).

**Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- Explore bacteria and viruses, including their structure, function, classification, pathogenesis, and interactions with hosts.
- Learn fundamental principles of microbiology and virology and their significance in various scientific disciplines, such as medicine, agriculture, and biotechnology.
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**Recommended Books:**

1. Black, J.G. 2005 Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
2. Prescott, L.M., Harley, J.P. and Klein, D.A. 2005. Microbiology McGraw-Hill Companies, Inc.
3. Arora, D.R. 2004. Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.
4. Ross F.C. 1995. Fundamentals of Microbiology. John Willey & Sons, New York.
5. Khan, J.A. and Dijkstra J. Plant Viruses as Molecular Pathogens. The Haworth Press, Inc.
6. Hull R. Matthews .2004. Plant Virology, Academic Press.
7. Tortora, G.J: Funke, B.R. and Case C.L.2004. Microbiology. Pearson Education.

8. Molecular Plant-Microbe Interactions, Kamal Bouarab, Normand Brisson, Fouad Daayf (eds)  
 .2009. MPG Books Group, Bodmin, UK.

9. Plant-Microbe Interactions Gary Stacey, Noel T. Keen (Eds) 2011.springer London

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|---|----------------------------|
| <b>Course Title:</b> General Immunology       | <b>Course Code:</b> MB-503 |
| <b>Course Structure:</b> Lectures: 3, Labs: 1 | <b>Credit Hours:</b> 4     |

**Prerequisites:** No

**Course Objective:**

The course objectives are to:

- To understand the basis of immunity, cells and organs involved in immunity.
- To understand the role of blood group and MHC in transplantation.
- To know about cancer immunology.
- To understand different disorders of immune system.

**Course Outline:**

Introduction: chronological development and scope of immunology. Immunity and immune responses: Definitions and types (specific and non-specific). Humoral and cellular immunity. Introduction to complement system. Cells and tissues of immune system. The antigens: structure (simple and complex molecules, proteins, and polysaccharides) and immunogenicity. Tissue antigens: the Allo- and heterophile antigens. The ABO and Rh blood group systems, their chemical basis, inheritance & clinical significance. Immunoglobulin: structure and function; classes, subclasses, types, and subtypes. Introduction to antigen-antibody reactions: methods for detecting antigens and antibodies (agglutination, precipitation, complement fixation, EIA, etc.). Introduction to HLA & MHC and its role in immune response, disease, and its significance in tissue transplantation. Immune-regulation and tolerance. Introduction to Cancer immunology. Autoimmune diseases and immune-deficiencies, immunization.

**PRACTICAL:**

1. Differential leukocyte count.
2. Blood grouping (ABO & Rh).
3. Immuno-diagnostic Methods.
4. Agglutination test (Widal test).
5. Precipitation tests.
6. Gel diffusion test.
7. ICT Test.

**Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- Explore the basic knowledge of immune system.
- Describe the concepts about the performance of immune system.
- Interpret the complications using immunological involvement.
- Identify the difficulties using immunological studies.
- Detect the using the immunological techniques for disease.

**Recommended Books:**

1. Chen, E. R. 2019. Deja Review: Microbiology and Immunology, McGraw-Hill Companies, N.Y.
2. Van Emon, V. M. 2006. Immunoassay and Other Bioanalytical Techniques, CRC Press, F.L.
3. Abbas, A. K., Lichtman, A. H. and Pillai, S. 2019. Cellular and Molecular Immunology, 9<sup>th</sup> edition, Elsevier Health Sciences, N.Y.

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|---|-----------------------------|
| <b>Course Title: Physiology</b>               | <b>Course Code: ZOL-555</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b> | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: None</b>                    |                             |
| <b>Course Objective:</b>                      |                             |

The objectives of the course are:

- To explore basic physiological principles common to animals.
- To integrate understanding about physiology from molecular to organism level.
- To explain physiological interactions between different systems.
- To introduce the concept of homeostasis and its relation to environment.

**Course Outline:**

**Introduction to physiology:** Definition, Structure-function Relationship, Importance. **Membrane physiology:** Resting Membrane Potential: Donnan equilibrium, ion channels, membrane receptors, action potential in nerves and muscles; Structure and function of electrical and chemical synapse. Molecular basis of muscle contraction; myoneural junction; skeletal and smooth muscle, Neurotransmitters. **Receptors Physiology:** Mechanoreception, Photoreception, Auditory, Vestibular and Chemical sensory system; Motor system within brain, Autonomic system and its control: Higher function of NS: consciousness, learning, memory. Physiology of digestion: Physiology anatomy of digestive tract, absorption of ions, nutrients and water; control of motility, gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; digestion and absorption of carbohydrates, proteins, lipids, vitamins, ions and water. Cardiovascular System: Physiology of cardiac muscles; cardiac cycle action potentials, Control of cardiac activity and peripheral circulation. Nervous and hormonal regulation of heart activity. Blood and homeostasis: Hemodynamics; Blood flow, pressures and resistance Arterial system; Microcirculation and lymphatic system. Respiratory system: Exchange of Gases: Transport of O<sub>2</sub> and CO<sub>2</sub> between respiratory surface (the lungs) and body cells. Regulation of lungs respiration; breathing; Respiratory responses in extreme conditions. Excretion and Osmoregulation: Aquatic and terrestrial environment excretion and osmoregulation. Problems of osmoregulation. Anatomy and physiology of kidney and nephron; glomerular filtration, tubular absorption and secretion; water and electrolyte balance, urine formation; Role of kidney in acid-base balance. Temperature relations of heterotherms and endotherms: Dormancy: Sleep, Torpor, Hibernation, Estivation. Environmental Challenges: Temperature and animal energetic; Temperature relation of Ectotherms,

Heterotherms and Endotherms.

**PRACTICAL:**

1. Study of reflex action through diagrams/Models.
2. Measurement of blood pressure using sphygmomanometer.
3. Measurement of human Heart activity through electrocardiography (ECG).
4. Human ABO blood group system.
5. Study of permanent slides (muscle cells, blood cells, cell organelles).

**Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- To acquire basic knowledge about animal systems and their physiology.
- To understand physiology from molecular to organism level.
- To understand the concept of homeostasis and its relation to environment.
- To acquire basic knowledge of classification of animals.
- To understand pathophysiology of common diseases related to the organ systems.

**Recommended Books:**

1. Moyes/Schulte, Principles of Animal Physiology, 5<sup>th</sup> edition, 2016, Cambridge University Press.
2. Richard Hill, Daniel J. Cavanaugh, Margaret Anderson, Animal Physiology, 2022, Oxford University Press.
3. Richard Hill, Gordon A. Wyse, Margaret Anderson Sinauer, Animal Physiology, 4<sup>th</sup> edition, 2016.
4. S.C. Rastogi, Essentials of Animal Physiology 4<sup>th</sup> edition, 2019, New Age International.
5. Patrick J. Butler, J. Anne Brown, D., Animal Physiology, 2021,

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|---|----------------------------|
| <b>Course Title: Introduction to Bioinformatics</b>   | <b>Course Code: BI-401</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b>   | <b>Credit Hours: 3</b>     |
| <b>Prerequisites: None</b>  |                            |
| <b>Course Objective:</b> This course is designed for students with little to no prior experience in |                            |

bioinformatics. It provides a foundational understanding of the core concepts, tools, and techniques in bioinformatics.

**Course Outline:**

Introduction to Bioinformatics, Biological Databases, Types of Biological databases, Human genome and browsers, Genome sequencing methods, sequencing of human genome, DNA, RNA, and protein sequences retrieval and analysis, Sequence alignment and BLAST, Pairwise and Multiple Sequence Alignment, Sequence Polymorphism, What is Phylogenetics, Phylogenetic tree construction and analysis, Structural Bioinformatics, Introduction to protein structure, PDB (Protein Data Bank), Protein structure visualization, Primer designing, Genomics and Proteomics, students Projects.

**PRACTICAL:**

Introduction to NCBI, Navigating the NCBI website, Comparison of sequences using Basic Local Alignment Search Tool (BLAST), Interpretation of BLAST search results, UCSC genome browser, Pairwise and multiple sequence alignment using ClustalW, Protein Data Bank, Swiss Prot, Pymol viewer or any available protein structure visualizer, Primer 3 and Oligo analyzer 3.1.

**Course Outcomes:**

- By the end of the course, students will be able to analyze biological data, perform basic sequence analysis, and grasp key principles in genomics and proteomics.

**Recommended Books:**

6. **Bioinformatics Sequence and Genome Analysis**, D.W. Mount, Cold Spring Harbor Laboratory Press 2004 2<sup>nd</sup> Edition. ISBN 0-87969-597-8.
7. Zvelebil, M. J., & Baum, J. O. (2008). **Understanding bioinformatics**. New York (N.Y.): Garland science.
8. Arthur M. Lesk, **Introduction to Bioinformatics**.5th Edition (2019).Oxford University Press.
9. Jin Xiong, **Essential Bioinformatics**,(2006), Cambridge University Press
10. Thomas Dandekar, Meik Kunz, **Bioinformatics An Introductory Textbook**, (2023), Springer-Verlag GmbH Germany, part of Springer Nature
11. Ignacimuthu SJ. **Basic Bioinformatics**, 2nd Edition (2005) Narosa Publishing House.

**SEMESTER VI**

|   |                             |
|---|-----------------------------|
| <b>Course Title:</b> Biological Techniques    | <b>Course Code:</b> ZOL-521 |
| <b>Course Structure:</b> Lectures: 3, Labs: 0 | <b>Credit Hours:</b> 3      |
| <b>Prerequisites:</b> No                      |                             |
| <b>Course Objective:</b>                      |                             |

The course objectives are to:

- To demonstrate the knowledge of skills.
- To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences.
- To develop basic understanding of the equipment handling/usage.
- To develop scientific and technical expertise, culture and work habits.
- To know how to collect and preserve animals.

### **Course Outline:**

**Microscopy:** Principles of light microscopy, Magnification, Resolution, Contrast, Types of microscopy (Phase Contrast Dark Field Interference microscope), Electron microscope (SEM and TEM); **Standard unit system for weight, length, volume:** Different Measurement systems (length; surface; weight, volume, temperature), Calculations and related conversions, Concentrations- percent volume; ppt; ppm - molarity, normality, molality, Preparation of stock solutions of various strengths; **Micrometry and Morphometry:** Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter); **Microtomy** (Specimen preparation for optical microscopy), Microtome, Types of microtomes, Steps of Microtomy (Fixation, dehydration, clearing, embedding, Section cutting, mounting and staining); **Separation and Purification techniques:** Cell fractionation, Centrifugation and its types, Filtration and its types, Distillation, Use of Soxhlet and Rotary evaporator for extraction; **Chromatography; Electrophoresis; Spectrophotometry:** Principle, applications, types, visible spectrum, UV spectrum, atomic absorption; **Sampling:** sampling types, sampling techniques and Sampling of different organisms; **Preservation:** Preservation of dry and wet specimens.

### **Course Outcomes:**

On completion of this course, the students should be able to:

- Identify the instruments.

- Use instrument for identification, measurement, fixing and cutting of tissue
- Apply a practical and research skill.
- Operate the lab equipment efficiently.
- Collect and preserve the specimen in dry and wet form.
- Develop expertise in Preservation techniques

**Recommended Books:**

1. Muthukumar. K .2020. Biological Techniques: Psychology Techniques.
2. Sue Carson, Heather B. Miller, et al. 2019 Molecular Biology Techniques: A Classroom Laboratory Manual. 4<sup>th</sup> edi. Academic press.
3. Kishore. R. Pawar. 2017. Biological Techniques Paperback. Nirali Prakashan.
4. Mukesh Doble. 2016. Principles of Downstream Techniques in Biological and Chemical Processes. Apple Academic Press; 1st edition.
5. W. Hanke, W. R. Schulue . 2012. Planar Lipid Bilayers: Methods and Applications (Biological Techniques Series) Kindle Edition Publisher Academic Press.

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|--|-----------------------------|
| <b>Course Title:</b> Research Planning and Report Writing  | <b>Course Code:</b> ZOL-522 |
| <b>Course Structure:</b> Lectures: 3, Labs: 0  | <b>Credit Hours:</b> 3      |
| <b>Prerequisites:</b> No   |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• Develop research skills.</li> <li>• Provide understanding how to design scientific research, to collect data and its interpretation.</li> <li>• Emphasize the importance of ethics in scientific research.</li> <li>• Enable students to write a research proposal.</li> </ul> |                             |

### Course Outline:

**Introduction:** Objectives of Research, Motivations; **Research Process:** Research methods vs. research methodology, scientific method, Types of research, general steps involved in research, Problems of research in Pakistan; **Topic Selection:** Problem identification for research, criteria and evaluation; **Literature review:** Importance and sources, Referencing and citation and Bibliography, plagiarism; **Research Design:** Parts, important features, important concepts in research design; **Aims and objectives:** Research objectives, qualities of research objectives; **Material and methods:** Bioethics, sampling, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources; **Data Analysis:** Processing, statistics in research, hypothesis testing, t-tests and ANOVA; **Scientific Writing:** Difference between thesis/report/synopsis/research proposal, Parts of synopsis/project proposal, parts of thesis/report; **Budgeting:** Cost estimates for a research project, funding sources e.g. USAID, HEC, DoST, HED, PMRC, WWF, PSF etc.

### Course Outcomes:

Upon successful completion of the course, the student will be able to:

- **Understand** a general definition of research design.
- **Identify** the overall process of designing a research study from its inception to its report.
- Become **familiar** with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- **Know** the primary characteristics of quantitative research and qualitative research.
- **Identify** a research problem stated in a study.
- Become **familiar** with how to write a good introduction to an educational research study.
- To **distinguish** a purpose statement, a research question or hypothesis, and a research objective.

### Recommended Books:

- John W. Creswell and J. David Creswell. 2017. Research Design: Qualitative, Quantitative, and Mixed

### Methods Approaches

- Kothari, C.R., &Gaurav, G. 2014. Research Methodology: Methods and Techniques. New Delhi: New Age International.
- Creswell, J. W. 2013. Research Design Quantitative Qualitative and Mixed Methods Approaches.Sage.
- Shanti, B. M 2011, Handbook of Research Methodology: A Compendium for Scholars & Researchers education publishing. ISBN: 978-1-5457-0340-3
- Kumar, R. 2011. Research Methodology: A Step By Step Guide for Beginners. Cornwall: SAGE Publications, Inc.

|   |                             |
|---|-----------------------------|
| <b>Course Title:</b> Animal Ecology   | <b>Course Code:</b> ZOL-523 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> None  |                             |
| <b>Course Objective:</b><br>The course objectives are to: <ul style="list-style-type: none"><li>• Enable the student to understand habitat and Ecology</li><li>• Develop expertise in the students about the contemporary themes of Ecology and ecosystems</li><li>• Understand global Environmental threats and their mitigation</li></ul>   |                             |
| <b>Course Outline:</b><br><b>Energy:</b> Basic Concepts of and Types of Ecology; <b>Laws of thermodynamics;</b> primary and secondary productions; <b>Trophic levels and energy variation</b> with increasing trophic levels, energy flow, food chains and food webs; <b>Biogeochemical cycle:</b> Nitrogen, Phosphorus, Sulphur, Water, Carbon and nutrient, Limiting factors, Basic Concepts, Temperature, Soil, Water and Humidity, Light and Fire; <b>Global ecosystems:</b> Atmosphere, Hydrosphere, Lithosphere and Ecosphere, An overview of Ecosystem with special reference to Ecological Niche, basic concepts and types; <b>Major ecosystem of world,</b> Forest, Grassland, Desert, Tundra and Agricultural ecosystems, Marine, Estuarine, Freshwater and Wetlands; <b>Population ecology:</b> Basic population characters, Growth and Growth Curves, Population Dynamics and Regulations; <b>Community</b> |                             |

**ecology:** Basic concepts, Community Analysis, Ecotones, Inter-population Interactions; **Applied Ecology:** resources and their ecological management, Mineral, Agricultural Desalination, Weather Modification, Forest and Range Management, Landscape and Land use; **Pollution:** Definition, Types, Water, Air, Land and Noise, Sources and Management; **Radiation ecology:** Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, Radioactivity leakage, Environmental laws); **Exotic and Invasive Species:** Desertification, Deforestation, exotic and invasive species.

### **PRACTICALS:**

1. Population Sampling Techniques (Quadrat, Line Transact, Point count, Focal Scan and Capture and Recapture Method).
2. Study of different Ecosystems (Fresh Water, Terrestrial, Marine/Mountain/ Desert).
3. Ecological Notes.
4. Measurements of physical Factors of different Ecosystems.
5. Adaptive features of animals in relation to food and environment.
6. Analysis of polluted and fresh water for biotic and abiotic variations.
7. Field visits for study of selected terrestrial habitat and writing notes.
8. Experimental design and approaches in ecological research; writing a research project.
9. Development of an ecological management plan of some selected area

### **Course Outcomes:**

On completion of this course, the students should be able to:

- Understand and apply the basic concepts of Ecology.
- Acquire theoretical knowledge for rehabilitation of destroyed ecosystems and habitats in the environment.
- Solve the ecological Problems and their management through scientific approach.

### **Recommended Books:**

1. Charles. S. Elton. 2022. *Animal Ecolog*. Legare Street Press
2. William H. Karasov and Carlos Martínez del Rio. 2020. *Physiological Ecology: How Animals Process Energy, Nutrients, and Toxins*, Princeton University Press.
3. Michael L. Morrison, Leonard A. Brennan , et al. 2020 *Foundations for Advancing Animal Ecology (Wildlife Management and Conservation)*. Johns Hopkins University Press.
4. Gerhard von der Emde. 2016. *The Ecology of Animal Senses: Matched Filters for Economical Sensing* 1st ed. Springer.
5. Michael Begon, Colin R. Townsend, Ecology,2020, Wiley.

|  |                             |
|--|-----------------------------|
| <b>Course Title:</b> Wildlife Conservation and Management  | <b>Course Code:</b> ZOL-525 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours:</b> 3(2+0) |
| <b>Prerequisites:</b> No   |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• Enable the student to understand philosophy and significance of wildlife conservation.</li> <li>• Understand the wildlife management rules and regulations in Pakistan.</li> <li>• Understand how National and International agencies are involved in conservation and management of wildlife.</li> </ul>  |                             |
| <p><b>Course Outline:</b></p> <p><b>Wildlife of Pakistan:</b> Introduction, Important Definitions, Identification, Distribution, Status; <b>Conservation and Management:</b> of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan, Philosophy and significance of wildlife conservation, Biodiversity and sustainability of wildlife; <b>Wildlife rules and regulations in Pakistan:</b> Provincial Rules, Federal Management of Wildlife (NCCW); <b>National and International agencies involved in conservation and management of wildlife:</b> National Organisations, International Organisations; <b>Protected Areas in Pakistan:</b> Sanctuaries, Game Reserves, National Parks;</p> |                             |

**Ramsar convention:** Wetlands, Ramsar Criteria, Ramsar Sites; **Threatened species of Pakistan:** Vulnerable, Endangered, Critically Endangered.

**PRACTICALS:**

1. Visit to protected areas of Pakistan (Captive, Semi-captive and Wild Areas)
2. Ecological Indices
3. Animal Distribution Maps

**Course Outcomes:**

On completion of this course, the students should be able to:

- **Acquire** theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan
- **Understand** the protected area system (Game Reserves, Wildlife Sanctuaries and National Parks).
- **Solve** the threats to wildlife by applying the scientific principles and modern technologies (Sustainable development through local community participation).

**Recommended Books:**

1. Paul R. Krausman. 2022. *Wildlife Management and Conservation: Contemporary Principles and Practices*. 2<sup>nd</sup> (edi). Johns Hopkins University Press. Uk.
2. Stephen A. Miller and John P. Harley. 2016. *Zoology*. 10<sup>th</sup> (edi). (International). Singapore: McGraw Hill.
3. John M. Fryxell. 2014. *Wildlife Ecology, Conservation, and Management* 3rd Edition. Wiley BlackWell. Uk.
4. Paul R. Krausman. 2013. *Wildlife Management and Conservation: Contemporary Principles and Practices*. 1<sup>st</sup> (edi) Johns Hopkins University Press. Uk.
5. Robinson, W.L. and Bolen, E.G., 2012. *Wildlife Ecology and Management*. McMillan, new edition Cambridge.
6. Khan M. S. 2011, *Amphibian and Reptiles of Pakistan*

|   |                             |
|---|-----------------------------|
| <b>Course Title:</b> Zoogeography   | <b>Course Code:</b> ZOL-528 |
| <b>Course Structure:</b> Lectures: 3, Labs: 0   | <b>Credit Hours:</b> 3      |
| <b>Prerequisites:</b> None  |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• To provide students with a solid understanding of significance of studying animal distributions in the context of ecological and evolutionary processes.</li> <li>• To explore the role of geological history, including continental drift, plate tectonics, and supercontinent breakup, in shaping animal distributions.</li> <li>• To categorize and understand various animal distribution patterns, including cosmopolitan, discontinuous, isolation, bipolar, and endemic distributions.</li> <li>• To emphasize the application of zoogeography in conservation biology, particularly in the context of endangered species and habitat preservation.</li> </ul>   |                             |
| <p><b>Course Outline:</b> Introduction and history of Zoogeography; Branches of zoogeography: descriptive, chorology, faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography. Animal distribution: a. cosmopolitan distribution; b. discontinuous distribution; c. isolation distribution; d. bipolar distribution; e. endemic distribution, Barriers to distribution and means of dispersal in Marine, Freshwater and Terrestrial environment. Palaeogeography: Pangea, Theories of continental drift and plate tectonics explaining discontinuous distribution of animals. Division of world into various zoogeographical regions: a. Zoogeographic Division and Boundaries; b. Geographic Ranges; c. Physical Features; d. Climates, e. Faunas and Affinities Of Palaearctic, Nearctic Regions, Oriental, Ethiopian, Australian, And Neotropical Regions; e. Insular Fauna: continental islands (Recent: British Isles, Borneo, Java, Japan, Formosa and Philippines, and Sri Lanka islands; Ancient: New Zealand and Madagascar Island) and Oceanic Islands (Azores, Bermuda, Galapagos, St. Helena and Karakatau Island), Wallace's line, Weber's line and Wallacea; Zoogeography of Pakistan: Major Ecological Zones of Pakistan.</p> |                             |
| <p><b>Course Outcomes:</b></p> <p>Upon successful completion of this course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Identify and categorize various animal distribution patterns.</li> </ul>   |                             |

- Evaluate the mechanisms and ecological significance of animal dispersal and migration.
- Assess natural and anthropogenic barriers affecting animal distribution patterns.
- Compare and contrast the zoogeography of major regions around the world.

**Recommended Books:**

1. Frank Evers Beddard Creative, A Text-Book of Zoogeography, 2022, Media Partners, LLC
2. Mark Lomolino, Brett Riddle, Robert J. Whittaker, Biogeography ,2017, Sinauer
3. Richard J. Ladle, Robert J. Whittaker, CONSERVATION BIOGEOGRAPHY,2011, Wiley.
4. C. Barry Cox, Richard J. Ladle, Peter D. Moore, Biogeography An Ecological and Evolutionary Approach,10th ed, 2020, Wiley.
5. Liliana Katinas, Jorge V. Crisci, Paula Posadas, Historical Biogeography An Introduction, 2<sup>nd</sup> Ed, 2009, Harvard University Press

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|---|-----------------------------|
| <b>Course</b><br><b>Name: Principles of Biotechnology</b>   | <b>Course Code: BIT-301</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 0   | <b>Credit Hours: 3</b>      |
| <b>Prerequisites:</b> None  |                             |
| <p><b>Course Objective:</b> 1. To acquaint students with the basic concepts and significance of biotechnology as it stands today.</p> <p>2. To understand application of basic biology in the field of biotechnology to solve problems</p> <p>3. To equip students with various techniques and concepts used in biotechnology</p> |                             |
| <p><b>Course Outline:</b></p> <p>Biotechnology, Introduction to biotechnology, definition, brief history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture (food,</p>   |                             |

livestock, fisheries, algae, fungi, etc.), resistant varieties, Bt crops; emerging Techniques in biotechnology, genetic engineering, tools and steps, enzymes for ligation and cutting DNA, applications, Bioprocessing and fermentation technology, fermenters, primary and secondary metabolites, Biotechnology in medicine, antibiotics, vaccines, Animal biotechnology, better animal production, transgenic animals, Environmental biotechnology, waste management and treatment methods, Industrial and microbial biotechnology, single cell proteins, bio fertilizers, protection of biotechnological products; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world

**Recommended Books:**

1. William J, Thieman J, Michael A (2003) 2<sup>nd</sup> edition, 'Introduction to Biotechnology' McGraw Hill Book company Inc
2. David, B., Jewell, T. R. 2000. Biotechnology: demystifying the concept, Oxford University Press.
3. Sedivy, J. M., Joyner, A. L. 2000. Gene targeting, Oxford University Press.
4. Mukhopadhyay, S.N, 2004. Process Biotechnology Fundamentals, 2<sup>nd</sup> Edition: Viva Books Pvt. Limited, New Delhi.
5. Goodsell, D.S., 2004. Bionanotechnology: Lessons from Nature . John Wiley & Sons Limited.
6. Purohit, S.S., 2002, Biotechnology: Fundamentals and Applications, Agrobios publishers.
7. Prave, P., Faust, U., Sittig, W., and Sukatsch, D.A., 2002. Fundamentals of Biotechnology, John Wiley & Sons

**SEMESTER VII**

|   |                             |
|---|-----------------------------|
| <b>Course Title:</b> Principles of Animal Systematics | <b>Course Code:</b> ZOL-632 |
| <b>Course Structure:</b> Lectures: 3, Labs: 0         | <b>Credit Hours:</b> 3      |
| <b>Prerequisites:</b> None                            |                             |
| <b>Course Objective:</b>                              |                             |

The course objectives are :

- To impart the knowledge of evolutionary/phylogenetic relationship (from simple to the complex organisms).
- To introduce the basic taxonomic characteristics and classification of all the invertebrate phyla.
- To inculcate understanding of body organization, Feeding and Digestive system; Other Organ System.
- To describe mode of Reproduction and Development.
- To discuss the information of their economic and ecological importance.

**Course Outline: Taxonomy and Systematics:** History of Taxonomy; from First Period to sixth period. Three Levels of Taxonomy. Systematics as the science of organic diversity. The contribution of systematics to biology. Systematics as a profession. The future of systematics strategies in taxonomic research; **Species Category/Species Concept:** Typological Species Concept. Nomenclature Species Concept, Biological Species Concept, cladistics species. Monotypic and Polytypic species, sub species, super-species. Sibling species; **Microtaxonomy /Intraspecific categories:** Population Taxonomy, Population structure. Intra-population Variation and the Comparison of Population Samples. Sympatric samples, Phenon or different species. Nongenetic variation, Genetic Variation; **Macrotaxonomy /Higher categories:** Taxon and Category. Basic principles of classification. Function of classification, Linnaean hierarchy. Higher categories and higher taxa, the process of ranking, Relationship, similarity and Difficulties. The improvement of existing classifications; **Taxonomic Characters:** Kinds of characters; Morphological Characters, Physiological Characters, Molecular Characters, Behavior Characters, Ecological Characters, Geographic Characters; **Taxonomic Procedures:** Collections, preservation, Process of Identification: Taxonomic keys, different kinds of keys and Curating of collections; **Zoological Nomenclature:** Rules of Zoological Nomenclature and Evolution of the theory of nomenclature. The International Code, interpretation and application of the code; **Formation of Specific Names:** Brief concept of cladistics, Theory and practice of cladistics and phylogenetic systematics.

**Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- Understand the importance and history of systematics with basic rules and regulations about the identification and naming of organisms.
- Acquire the knowledge of diversification of living forms, both past and present, and the [relationships](#) among living things through time.
- Apprehend the evolutionary history of life on Earth.
- Visualize relationships as evolutionary trees (synonyms: [cladograms](#), [phylogenetic trees](#), phylogenies).
- Analyze the phylogenetic trees of species and higher [taxa](#).
- Acquire the knowledge of evolution of traits (anatomical or molecular characteristics) and the distribution of organisms ([biogeography](#)).

**Recommended Books:**

1. Yowann Byghan. 2020. Sacred and Mythological Animals: A Worldwide Taxonomy. McFarland.
2. V.C. Kapoor (author). 2019. Theory and Practice of Animal Taxonomy and Biodiversity 8Ed. CBS Publishers & Distributors Pvt Ltd, India
3. Austin Balfour. 2016. Principles of Plant and Animal Taxonomy. 1<sup>st</sup> edition. USA.
4. Ashok Verma. 2015. Principles of Animal Taxonomy. India
5. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2<sup>nd</sup> Ed. Wiley-Blackwell.

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|--|-----------------------------|
| <b>Course Title:</b> Animal Reproductive Biology | <b>Course Code:</b> ZOL-633 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1    | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> No                         |                             |

**Course Objective:**

The course objectives are to:

- . Understand on the molecular and cellular mechanisms of physiological function as the basis of unity in diverse animals e.g. membrane excitability, exchange of respiratory gases, removal of nitrogenous wastes tissue, osmotic and organ physiological mechanisms underlying animal homeostasis and temperature effects.
- Grasp the development of performing the function developed at molecular and cellular level in the complexity of the animals such as chemical & nervous integration, respiratory and excretory functions. 3. Know the strategy acquired to perform the functions in diverse environment such as in dry & aquatic and cold and hot at molecular and cellular level and regulations to achieve strategy by chemical and nervous regulation at organ levels.
- Comprehend the concepts in homeostasis and integration in sustaining the life in constantly changing conditions.

**Course Outline: Introduction:** Overview of biology of reproduction; reproductive strategies, comparative aspects.; **Anatomy of reproductive system:** male reproductive system, female reproductive system; functional histology of male and female reproductive system; **Neuroendocrine control of reproduction:**. Pituitary and hypothalamus. Physiology of testicular function. Organization; endocrinology, regulation; immunology; **Physiology of sperm maturation and fertilization:** Epididymal function, ejaculation, fertilization, capacitation. Reproductive cycles: pre- and neonatal development; puberty, estrous cycle, breeding seasons, aging; **Physiology of ovarian function:** folliculogenesis, egg maturation, ovulation, endocrinology, regulation.; **Transport of gametes:** sperm and ovum, development in oviduct, ; **implantation.**

**Practicals:**

1. Demonstration of male and female reproductive system in vertebrates.
2. Histological studies of ovaries, testes and different endocrine glands.
3. Radioimmunoassays of different hormones.

**Course Outcomes:**

On completion of this course, the students should be able to:

- Analyse critical concepts, processes, and factual information in the performance of functions and changing conditions.
- Gain knowledge of resources for finding the solution for strategies to sustain diverse forms of animal life kept and in wild in normal and abnormal conditions.
- Utilize knowledge of animal physiology in critical study and for making intelligent decisions in professional life.

**Recommended Books:**

1. Eberhard Nieschlag, Hermann M. Behre, Susan Nieschlag, Andrology, 2010, Springer Berlin Heidelberg.
2. María-José Argente, Insights from Animal Reproduction, 2023, DI Press
3. Kazuya Kobayashi, Mariko Kondo, Takeshi Kitano, Yasuhiro Iwao, Reproductive and Developmental Strategies The Continuity of Life, 2018, Springer Japan
4. An Introduction To Embryology 5th Ed Balinsky 2015
5. Sastry, Developmental Biolog, 2019.
6. Langman's Medical Embryology South Asian 14th Ed, 2019, Sadler

**Course Title:** Entomology

**Course Code:** ZOL-634

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|--|-----------------------------|
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3(2+1)</b> |
| <b>Prerequisites: No</b>   |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are :</p> <ul style="list-style-type: none"> <li>• To introduce classification of insect of different classes.</li> <li>• To study morphology of insects.</li> <li>• To impart knowledge about insect significance its relationship with diseases.</li> </ul>   |                             |
| <p><b>Course Outline:</b></p> <p><b>Introduction:</b> A general account including classification of insect order Collembola, orthopteran, Dictyoptera, Isoptera, Hemiptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera. Only diagnostic characters of the remaining insect orders Thysanura, Diplura, Protura, Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea, Phasmida, Dermaptera, Embioptera, Zoraptera, Psocoptera, Mallophaga, Siphunculata Thysanoptera, Neuroptera Mecoptera, Trichoptera, Siphonaptera strepsiptera ; <b>Insects of economic importance;</b> Integument, Head of an orthopteroid insect Thorax sclerites of a typical wing bearing segment, Hypothetical primitive venation pattern wing, regions and modifications. Segmentation and functions of legs, Abdomen, Its segmentation appendages and processes, Structure of typical male and female external genitalia; <b>Soft parts Morphology and physiology of various system</b> including embryology (upto dorsal closure) and metamorphosis (excluding organogenesis); <b>Ecology Trophic relationship:</b> Competition, Social systems and behavior populations under insecticidal stress; <b>Biological control strategies in Reproduction.</b></p> <p><b>PRACTICAL:</b></p> <ol style="list-style-type: none"> <li>1. Dissection of Cockroach, grasshopper, red cotton bug, Gryllus butterfly honey-bee yellow wasp house fly and mosquito drosophila.</li> <li>2. Microscopic preparations: Mouth-parts, wings, legs, genitalia of the above insects.</li> <li>3. WholeMounts: Collembola, silver fish, thrips, birds-louse antlion aphids, whiteflies, fig insects, Head</li> </ol> |                             |

Louse, fleas

**Course Outcomes:**

Upon successful completion of the course, the student will be able to:

- **Comprehend** classification of insect of different classes.
- **Elaborate** morphology of insects.
- **Understand** insect significance its relationship with diseases.

**Recommended Books:**

1. Nation, Sr., J. L. Insect Physiology and Biochemistry 4<sup>th</sup> edition. (2022). United Kingdom: Taylor & Francis Group.
2. Entomology and Pest Management: 7<sup>th</sup> edition. (2021). Waveland Press
3. Byrd, J., H., & Tomberlin, J., K. Forensic Entomology: The Utility of Arthropods in Legal Investigations. (2020). United Kingdom: CRC Press, Taylor & Francis Group.
4. Insect Biodiversity: Science and Society 2<sup>nd</sup> edition. (2017). United Kingdom: Wiley
5. Gullan, P. J., & Cranston, P. S. The Insects: An Outline of Entomology (2014). 5<sup>th</sup> edition. India: Wiley.

**SEMESTER VIII**

|   |                             |
|---|-----------------------------|
| <b>Course Title:</b> Endocrinology  | <b>Course Code:</b> ZOL-641 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> None  |                             |
| <b>Course Objective:</b><br>The course objectives are: <ul style="list-style-type: none"><li>• To introduce the field of Endocrinology and its significance</li></ul> |                             |

- To impart knowledge about mechanism of hormone action.

**Course Outline: An overview of general concepts and principles of endocrinology:** The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feedback, biorhythms, pathology and assessment of endocrine function; Evolution of endocrine system; **Hypothalamus and pituitary:** Hypothalamic hormones: Origin, chemistry and actions; hormones of anterior pituitary: Hypothalamic pituitary regulation, General chemistry, Physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: Release, regulation and actions of vasopressin and oxytocin; **Thyroid gland:** Anatomy and histology; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function. Calcitrophic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, metabolism of calcium and phosphate and magnesium; **Parathyroid gland,** Calcitonin and Cholecalciferol; Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides; **Adrenal Gland:** Adrenal Medulla and Catecholamines: Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors. Adrenal Cortex: Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids. Hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress.; **Energetics of reproduction:** functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroids at different stages of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action; **Endocrinology of heart Heart, Kidney, pineal gland;**

**Functional Diversity of Hormones in Vertebrates; Overview of Endocrine Mechanisms in Invertebrates; Neuroendocrinology;** structural and functional abnormalities in endocrine glands, pharmaco-endocrinology

**PRACTICALS:**

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc.
2. Histological and ultrastructure features of endocrine glands
3. Experiments to demonstrate physiological roles of hormones of different endocrine glands;
4. Experiments to demonstrate regulation of hormones' releases. Experiments to demonstrate functional diversity of hormones in different vertebrates.
5. Experiments on endocrine mechanism in vertebrates.
6. Radioimmunoassay of hormones.

**Course Outcomes:**

After studying this course student must be able to:

- **Understand** the fundamental anatomy endocrine glands in various mammalian species
- **Acquire** knowledge about histology and physiology of the male and female hormone system
- **Comprehend** the basic patterns and periodicity of processes controlled by hormones.
- **Elaborate** the socio-economic problems related to hormone imbalance.

**Recommended Books:**

1. Elizabeth H. Holt 2021. Goodman's Basic Medical Endocrinology 5th Edition, Elsevier.
2. Elite Publishing, 2021. Endocrinologist. Independently published.
3. Richard I. G. Holt. 2021. Essential Endocrinology and Diabetes, 7th Edition. Wiley-Blackwell.

4. Shlomo MD Melmed. 2020. Williams Textbook of Endocrinology. Elsevier.
5. David G. 2017. Gardner Greenspan's Basic and Clinical Endocrinology, Tenth Edition (Greenspan's Basic & Clinical Endocrinology) 10th Edition, McGraw Hill / Medical.
6. Handbook of Diagnostic Endocrinology. (2020). Netherlands: Elsevier Science.
7. Schreiber, A. General and Comparative Endocrinology: An Integrative Approach (2023). CRC Press.
8. David O. Norris, D., O., & Carr, J., A. Vertebrate Endocrinology ,6<sup>th</sup> edition(2020), Academic press
- 9.

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|--|-----------------------------|
| <b>Course Title:</b> Developmental Biology   | <b>Course Code:</b> ZOL-642 |
| <b>Course Structure:</b> Lectures: 3, Labs: 0  | <b>Credit Hours:</b> 3      |
| <b>Prerequisites:</b> None   |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• Provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development</li> <li>• Impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction.</li> <li>• Provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis.</li> </ul> |                             |
| <p><b>Course Outline: Introduction; History and Basic Concepts of developmental biology; Principal features of developmental biology and embryology with special emphasis on vertebrate models: Origin of sexual reproduction, Developmental patterns; <u>Spermatogenesis</u>: Mammalian spermatogenesis as model for all vertebrates, Spermiogenesis or (spermatiosis), The role of Sertoli and</b></p>   |                             |

Leydig cells in spermatogenesis, Hormonal control of spermatogenesis; **Primates Menstrual cycle**; **Oogenesis**: Mechanism of oogenesis among various classes of vertebrates, Vitellogenesis, Hormonal control of Vitellogenesis and oogenesis; **Fertilization**: External & Internal Fertilization, Species-specific recognition of sperm and egg, Fusion of male and female gametes; **Polyspermy**: slow and fast blocks to polyspermy, Activation of egg metabolism; **IN VITRO Fertilization (IVF)**; History, Steps and advantages of IVF; Disadvantages and risk factors; **Cleavage & Blastulation**, Patterns of embryonic cleavage and blastulation among different vertebrate classes, Mechanism of cleavage; **Gastrulation**: Fate maps, Gastrulation in amphibians, birds and mammals; **Early Vertebrate Development**: Neurulation, ectoderm, mesoderm and endoderm formation; **Placenta and extraembryonic membranes**: Cellular Basis of Morphogenesis, Differential cell affinity, cell adhesion molecules, Organogenesis, Mechanism of teratogenesis; **Aging** and Regeneration in vertebrates

#### **Course Outcomes:**

After studying this course student must be able to:

- **Gain** familiarity with features that make an organism model for the learning of developmental biology *e.g.*, fertilization in sea urchin with mammalian like mechanisms.
- **Apprehend** the contributions of the sperm and the egg to form zygote
- **Elucidate** the problems associated with cell differentiation through fate mapping.
- **Arrange and investigate** the classical and modern experiments into “find it” , “block it” , and “move it” categories
- **Assess** the set of experiments that will establish whether a planned aspect is both necessary and ample to cause a developmental episode
- **Demonstrate** the ability to label macromeres, mesomeres, and micromeres and know which cell types are derived from each of these cell layers in the early embryo (*e.g.*, primary and secondary mesenchyme, ectoderm, endoderm, and mesoderm).

**Recommended Books:**

1. Bruce M. Carlson MD PhD. 2023. Human Embryology and Developmental Biology. 7<sup>th</sup> Ed. Elsevier.
2. Michael Barresi . 2023. Developmental Biology. OUP. USA.
3. Michael J.F. Barresi. 2020. Developmental Biology. OUP. USA
4. Gilbert S. 2016. Developmental Biology.11<sup>th</sup> Ed. Sinaeur
5. Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA.
6. Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.

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|--|-----------------------------|
| <b>Course Title: Parasitology</b>  | <b>Course Code: ZOL-643</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3(2+1)</b> |
| <b>Prerequisites: No</b>   |                             |
| <b>Course Objective:</b><br><p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• To impart knowledge on various parasites affecting human and animals.</li> <li>• To understand basic principles of parasitic infection and the host responses.</li> <li>• To familiarize students to differentiate among the common groups of parasites.</li> <li>• To improve their diagnostic assistance through basic/advance diagnostic techniques.</li> </ul>   |                             |
| <b>Course Outline: Introduction:</b> History and origin of parasitism, science and terminology; <b>Host-parasite relationships:</b> Brief account of animal associations, Adaptions to parasitic mode of life, theory of parasitism, behavior, transmission of parasites, evolution of parasites, ecology of parasites, habitat, parasite physiology, geographical distribution of parasite, host specificity, host Responses: resistance, tolerance, immunity, and types of parasites and host(Brief account and examples); <b>Protozoology:</b> Protozoan parasites of man and other animals, classification, life cycle, habitat, morphology,epidemiology and |                             |

immunopathology of infections e.g., *Entamoeba* spp. Pathogenic amoeba, *Giardia* spp., *Trichomonas*, *Trypanosoma*, *Leishmania*, *Coccidia*, *Plasmodium* and other protozoan parasites of importance; **Helminthology:** Helminth parasites of man and other animals, general account, classification, biology, lifecycle, pathology and immunology. Platyhelminthes: e.g. *Polysystema*, Trematodes: e.g., *Fasciola*, *Schistosoma*, *Diplostomun*. Cestodes: e.g. *Taenia*, *Diphyllobothrium*, *Acanthocephalas* (spinyheaded worms). Nematodes: *Trichuris*, *Trichinella*, *Strongyloides*, *Ancylostoma*, *Trichostrongylus*, *Haemonelm*, *Toxocara*, *Filaria* worms etc; **Medical and Veterinary Entomology:** Biology and classification of arthropods of veterinary and medical importance. Arthropods as parasites and blood suckers. Biology and life cycle e.g. crustaca, linguatolids, lice, mites, ticks, mosquitoes, fleas, flies, bugs etc. Effects of bites, allergies, pathology and immunology. Arthropods as disease transmitters/vectors.

#### **Course Outcomes:**

After studying this course student must be able to:

- **Acquire** knowledge of Parasites and philosophy of host-parasite interface.
- **Understand** the perception of parasitism and other animal associations.
- **Comprehend** association of parasite with its host through parasite life history.
- **Diagnose** the parasitic infections through current diagnostic techniques

#### **Practicals:**

- Study of the prepared slides and preserved specimens of parasites: protozoan parasites, helminth parasites, arthropod parasites.
- Preparation and staining of slides for the study of structure of egg/larvae of helminth parasites, protozoan parasites and arthropod parasites.
- Techniques of collection of parasite samples, preservation and preparation of slides for the study of the morphology.
- Identification of vector hosts in various habitats and their morphology.

- Heamatological studies of blood samples of infected/non-infected hosts (sheep/goat, chicken/fish).

**Recommended Books:**

1. Bush, A.O., Fernandez, J.C., Esch, G.W. and Seed, J.R., 2001. Parasitism: The diversity and Ecology of animal parasites. Cambridge University Press, Cambridge, U.K.
2. Taylor, M., A., Coop, R., L., & Wall, R., L. Veterinary Parasitology (2015). 4<sup>th</sup>edition. Wiley
3. Holdsworth, P. Epidemiology in Small Animal Parasitology. Climate Change and Social, Economic and Political Factors (2020). Spain: GrupoAsis.
4. Chaudhury, A., & Parija, S., C. Textbook of Parasitic Zoonoses. (2022). Singapore: Springer Nature Singapore.
5. Lucius, R., Loos-Frank, B., Lane, R. P., Poulin, R., Roberts, C., Grensis, R. K. The Biology of Parasites (2017). Germany: Wiley.
6. Loker, E., S., & Hofkin, B., V. Parasitology: A Conceptual Approach (2020). 2<sup>nd</sup> edition United States: CRC Press.



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR  
DEPARTMENT OF ZOOLOGY**

**LIST OF ELECTIVE COURSES**

| <b>S<br/>. No.</b> | <b>Course Title</b>                   | <b>Cour<br/>se Codes</b> | <b>T<br/>heory</b> | <b>Pr<br/>actical</b> | <b>C<br/>redit<br/>Hours</b> |
|--------------------|---------------------------------------|--------------------------|--------------------|-----------------------|------------------------------|
| 1.                 | Comparative Animal Physiology         | ZOL- 664                 | 2                  | 1                     | 3                            |
| 2.                 | Comparative Endocrinology             | ZOL-665                  | 2                  | 1                     | 3                            |
| 3.                 | Host Parasite Relationship in Animals | ZOL-666                  | 2                  | 1                     | 3                            |
| 4.                 | Clinical Bacteriology                 | ZOL-667                  | 2                  | 1                     | 3                            |
| 5.                 | Medical Virology                      | ZOL-668                  | 2                  | 1                     | 3                            |
| 6.                 | Faunal Biodiversity of Pakistan       | ZOL-669                  | 2                  | 1                     | 3                            |
| 7.                 | Fish Nutrition and Health             | ZOL-<br>671              | 2                  | 1                     | 3                            |
| 8.                 | Human Genetics                        | ZOL-<br>672              | 2                  | 1                     | 3                            |
| 9.                 | Epidemiology of Animal Parasites      | ZOL-<br>673              | 2                  | 1                     | 3                            |

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|-----|---------------------------------------|-------------|---|---|---|
| 10. | Wildlife of Pakistan                  | ZOL-<br>674 | 2 | 1 | 3 |
| 11. | Quantitative Zoology                  | ZOL-<br>675 | 2 | 1 | 3 |
| 12. | Behavioral Ecology                    | ZOL-<br>676 | 2 | 1 | 3 |
| 13. | Ornithology                           | ZOL-<br>677 | 2 | 1 | 3 |
| 14. | Mammalogy                             | ZOL-<br>678 | 2 | 1 | 3 |
| 15. | Aquaculture and Fisheries             | ZOL-<br>679 | 2 | 1 | 3 |
| 16. | Biotechnology in Aquaculture          | ZOL-<br>680 | 2 | 1 | 3 |
| 17. | Limnology                             | ZOL-<br>681 | 2 | 1 | 3 |
| 18. | Wildlife Ecology                      | ZOL-<br>682 | 2 | 1 | 3 |
| 19. | Wildlife techniques and data analysis | ZOL-<br>683 | 2 | 1 | 3 |
| 20. | Vector Biology                        | ZOL-<br>684 | 2 | 1 | 3 |
| 21. | Population Genetics                   | ZOL-<br>685 | 2 | 1 | 3 |
| 22. | Bioremediation                        | ZOL-<br>686 | 2 | 1 | 3 |
| 23. | Biology and control of vertebrate     | ZOL-        | 2 | 1 | 3 |

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**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR  
DEPARTMENT OF ZOOLOGY**

**DETAILS OF ELECTIVE COURSES**

|  |                             |
|--|-----------------------------|
| <b>Course Title:</b> Comparative Animal Physiology   | <b>Course Code:</b> ZOL-664 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> No   |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• Understand on the molecular and cellular mechanisms of physiological function as the basis of unity in diverse animals e.g. membrane excitability, exchange of respiratory gases, removal of nitrogenous wastes tissue, osmotic and organ physiological mechanisms underlying animal homeostasis and temperature effects.</li> <li>• Grasp the development of performing the function developed at molecular and cellular level in the complexity of the animals such as chemical &amp; nervous integration, respiratory and excretory functions.</li> <li>• Know the strategy acquired to perform the functions in diverse environment such as in dry &amp; aquatic and cold and hot at molecular and cellular level and regulations to achieve strategy by chemical and nervous regulation at organ levels.</li> <li>• Comprehend the concepts in homeostasis and integration in sustaining the life in constantly changing conditions.</li> </ul> |                             |

**Course Outline: Homeostasis, nutrition and physiology of:** Metabolism and basal metabolic rate.

**Bioluminescence; Bioelectricity:** resting potential, action potential and its propagation, Nernst equation;  
**Skeletal and smooth muscle:** its properties, dynamic and molecular aspects of muscle contraction, all or none law kinds of contractions, twitch, tetanus, tonus; **Respiration and adaptive mechanisms:** in aquatic, terrestrial environment and in the transition stage; **Heart and vessels** in fish, amphibian and mammalian levels; **Excretion and osmoregulation:** ammonia, urea, uric acid excretion, water conservation and counter current mechanism; **Organization of nervous system:** neuron, reflex arc, spinal and cranial pathways, autonomic outflow, sensory structures, morphological correlates of information processing, neurotransmitters. Chemoreceptor adaptations at various levels; **Endocrine glands, hormones (vertebrates and invertebrates); Reproductive strategies and morphological change from fish to mammals:** Oviparity, viviparity and ovo-viviparity, Reversal of sex.

#### **Course Outcomes:**

After studying this course student must be able to:

- Acquire an understanding of critical concepts, processes, and factual information in the performance of functions and changing conditions.
- Gain knowledge of resources for finding the solution for strategies to sustain diverse forms of animal life kept and in wild in normal and abnormal conditions.
- Develop an ability to utilize knowledge of animal physiology in critical study and for making intelligent decisions in professional life.

#### **Practicals:**

1. Study of temperature optima and pH on a selected digestive enzyme (amylase).
2. Human blood counts. Measurement of haemoglobin and haematocrit.
3. Measurement of blood pressure and effect of stress.
4. Effect of vasoconstrictors and vasodilators on heart beat of frog.
5. Measurement of osmolality. Experiments on absorption of glucose in intestine & inverted sac

technique).

6. Effects of acetylcholine and epinephrine on intestinal movements.
7. Determination of oxygen consumption in an aquatic animal.
8. Determination of oxygen consumption in a terrestrial animal and effect of a factor.
9. Cardiac cycle in a frog and effect of temperature.
10. Effect of ions and drugs on cardiac activity in a frog.
11. Extra systole in cardiac activity.
12. Preparation of gastrocnemius muscle in a frog and study of simple twitch, summation and tetany.
13. Effect of temperature, acetylcholine and epinephrine on cardiac muscle activity.
14. Examination of endocrine glands from fish to mammals.
15. Study of physiological action of a hormone.
16. Effect of ablation of a gland and replacement therapy.
17. Study of rhythm in reproduction in a mammal.
18. Movement of chemicals and ions across cell membrane (erythrocytes hemolysis techniques).
19. Analysis of behaviour in selected animals, with the help of films shows/video, movies.

**Recommended Books:**

1. Randall, D. Burggren, W. and French K. 1997. Eckert Animal physiology – Mechanisms and Adaptations. 4<sup>th</sup> edition. WH. Freeman, NY USA
2. Satish Kumar Jindal, Introduction to Animal Physiology, 2011, New India Publishing Agency.
3. Animal Physiology verma, 2018
4. Animal Physiology and Biochemistry, revised edition agarwal 2018
5. Hicks, J., & Wang, T. Conceptual Breakthroughs in Comparative Animal Physiology (2023). United States: Elsevier Science

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|--|-----------------------------|
| <b>Course Title:</b> Comparative Endocrinology   | <b>Course Code:</b> ZOL-665 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> No   |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are :</p> <ul style="list-style-type: none"> <li>• To discuss the definition of hormone in terms of its general properties.</li> <li>• To differentiate among endocrine, paracrine and autocrine system.</li> <li>• To categorize different classes and chemical structure of hormone.</li> <li>• To explain the roles of the endocrine system in maintain homeostasis, integrating growth and development, responding to environmental insult and promote successful reproduction.</li> </ul>  |                             |
| <p><b>Course Outline: Introduction to hormones &amp; endocrine glands</b> – hypothalamus, pituitary (master gland), thyroid, parathyroid, adrenal cortex and medulla, pancreas, ovary and testes – their morphology and hormones released – target organs and effect; <b>positive and negative feedback mechanism:</b> hypothalamus releasing factor, growth hormone, GnRH, gonadotrophins (LH, FSH, hCG), TSH, T<sub>3</sub> and T<sub>4</sub> oxytocin, prolactin, ADH, insulin, Glucagon, adrenocorticoids, synthesis of and biological action, regulation and effects of adrenalectomy; <b>pregnancy hormones; regulation and action of androgens and ovarian hormones; Comparison of endocrine glands of vertebrates; the development of glands from pieces to mammalian;</b> hypothalamus, pituitary, pineal, thyroid, pancrease and adrenal glands; <b>Pheromones</b> – their secretion and action.</p> <p><b>PRACTICAL:</b></p> <ol style="list-style-type: none"> <li>1. Histological studies of endocrine glands of rats, chicken and uromastrix.</li> <li>2. RIA assays of various hormones (prolactin, thyroid hormones, growth hormone, FSH, LH).</li> <li>3. Extraction of pituitary gland of rat and fish.</li> </ol> |                             |

**Course Outcomes:**

After studying this course student must be able to:

- Explain the roles of the endocrine system in maintaining homeostasis, integrating growth and development, responding to environmental insult and promote successful reproduction
- Differentiate among endocrine, paracrine and autocrine system.
- Describe different classes and chemical structure of hormone.
- Identify the glands, organs, tissues and cell that synthesize and secrete hormones, hormone precursors and associated compounds.
- Elaborate synthesis and mode of secretion of hormone.
- Analyze how the secretion of hormone is regulated, including the principles of negative and positive feedback mechanism.
- Comprehend the importance of patterns of hormone secretion such as pulsatile, diurnal and cyclic.

**Recommended Books:**

1. David O. Norris, D., O., & Carr, J., A Vertebrate Endocrinology (2020). Academic press
2. Schreiber, A. General and Comparative Endocrinology: An Integrative Approach (2023). CRC Press.
3. Shifrin, A., L. Advances in Treatment and Management in Surgical Endocrinology (2019). Netherlands: Elsevier Health Sciences.
4. Handbook of Diagnostic Endocrinology. (2020). Netherlands: Elsevier Science.
5. Robert Hardin Williams, P. Reed Larsen, Williams, Textbook of Endocrinology, ·2003, Saunders

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|--|-----------------------------|
| <b>Course Title: Host Parasite Relationship<br/>in Animals</b> | <b>Course Code: ZOL-666</b> |
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|---|-----------------------------|
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3(2+1)</b> |
| <b>Prerequisites: No</b>  |                             |
| <p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• Describe general principles and concepts of animal parasitology</li> <li>• Classify major animal parasites of animals and humans.</li> <li>• Describe many of the disease conditions that animal parasites cause</li> <li>• Consider measures that may lead to control of these disease agents.</li> </ul>  |                             |
| <p><b>Course Outline: Classification of parasites:</b> Ectoparasites, endoparasites, temporary parasites, permanent parasites, facultative parasites, accidental parasites, wandering parasites (brief account and examples); <b>Classification of hosts:</b> Definitive, intermediate and paratenic hosts; <b>Parasites of wild animals and birds;</b> Role of wild animals and birds in dissemination of parasitic disease of domestic animals and man. Pathogenesis . Diagnosis and control of ecto and endo-parasites of wild animals and birds; <b>Host susceptibility and specificity:</b> Various types of susceptibilities, Host-parasite relationships, Morphology and physiology of parasites, Adaptations to parasitic mode of life, Effects of parasitism on parasites, Effects of parasites on hosts, Influence of parasites on host populations, Pathological responses ; <b>Immunoparasitology:</b> immunity and immune responses of host; <b>Diagnosis, prevention, control treatment:</b> Common drugs and anthelmintics , Vector control methods. Animal association, adaptation to parasitism, protozoa, mollusca, arthropoda, acarina, insecta, nematode, acanthocephala, trematoda, cestoda;. <b>Host specificity:</b> action of parasite upon their host.</p> <p><b>PRACTICALS:</b></p> <ol style="list-style-type: none"> <li>1. Culture, isolation and separation of parasitic larvae from soil and herbage material.</li> <li>2. Baermann technique for nematode larvae separation.</li> <li>3. McMaster technique for egg per gram counting,.</li> <li>4. Field herbage collection for coprological examination.</li> </ol> |                             |

**Course Outcomes:**

After studying this course student must be able to:

1. Assess general principles and concepts of animal parasitology
2. Analyze many of the disease conditions that animal parasite cause and to consider measures that may lead to control of these disease agents

**Recommended Books:**

1. Robert Curtis Anderson, Roy Clayton Anderson, Nematode Parasites of Vertebrates, 2000, CABI Pub.
2. Taylor, M., A., Coop, R., L., & Wall, R., L. Veterinary Parasitology (2015). 4<sup>th</sup> edition. Wiley
3. Holdsworth, P. Epidemiology in Small Animal Parasitology. Climate Change and Social, Economic and Political Factors (2020). Spain: GrupoAsis.
4. Chaudhury, A., & Parija, S., C. Textbook of Parasitic Zoonoses. (2022). Singapore: Springer Nature Singapore.
5. Lucius, R., Loos-Frank, B., Lane, R. P., Poulin, R., Roberts, C., Grensis, R. K. The Biology of Parasites (2017). Germany: Wiley.
6. Loker, E., S., & Hofkin, B., V. Parasitology: A Conceptual Approach (2020). 2<sup>nd</sup> edition United States: CRC Press.

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|---|-----------------------------|
| <b>Course Title:</b> Clinical Bacteriology                  | <b>Course Code:</b> ZOL-667 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1               | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> No                                    |                             |
| <b>Course Objective:</b>                                    |                             |
| The course objectives are to:                               |                             |
| 1. Describe general principles and concepts of Bacteriology |                             |

2. Classify major types of bacterias.

3. Describe many of the disease conditions that are caused by pathogens.

**Course Outline: Introduction:** Source of infection; **types of infection** – summer borne and winter borne diseases. Endemic, epidemic, sporadic and pandaemic diseases – especially with reference to Pakistan. **Transmission of pathogen** – animal to man and vice versa; **Control of transmission; Diagnostic Microbiology** – microbiological techniques involved in diagnosis of various bacterial infections. Opportunistic bacterial pathogens; obligate pathogens and associated diseases; **signs and symptoms; pathogenesis; control an treatment:** of *staphylococcus: streptococcus: pneumococcus; Lactobacillus; bordetella; Corynebacterium; Listeria; Hemphilus; Mycobacterium; Pseudomonas; Aeromonas; Vibrios; Bacillus; Clostridium; Enterobacteriaceae-Escherichia; shigella; Salmonella; Enterobacter; Klebsiella; Proteus; Serratia species* infections.

**PRACTICAL:**

1. Interaction of microbes and host: epidemiology, Koch’s postulates.
2. Isolation, identification and characterization of bacteria from various clinical samples: urine, skin, stool, blood, sputum etc.

**Course Outcomes:**

After studying this course student must be able to:

1. Assess general principles and concepts of clinical bacteriology
2. Analyze many of the disease conditions that are caused by bacterias.

**Recommended Books:**

1. Robert Jones Clinical Bacteriology. (2022). United States: Murphy & Moore Publishing.
2. , N. Clinical Microbiology E-Book (2019). Elsevier Health Sciences.
3. Parija, S,. C. Textbook of microbiology and immunology(2023). 4<sup>th</sup> edition Springer.

4. Murray, P. R., Rosenthal, K., & Pfaller, M. A. Medical Microbiology: Medical Microbiology E-Book (2020). 9<sup>th</sup> edition. Elsevier Health Sciences.

5. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. Medical microbiology (2015). 8<sup>th</sup> edition. Elsevier Health Sciences.

6. Burrell, C. J., Howard, C. R., & Murphy, F. A. Fenner and White's medical virology (2016). 5<sup>th</sup> edition. Academic Press.

7. Flint, S. J., Racaniello, V. R., Rall, G. F., Hatzioannou, T., & Skalka, A. M. Principles of virology, pathogenesis and control (2020). 5<sup>th</sup> edition. John Wiley & Sons.

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|--|-----------------------------|
| <b>Course Title:</b> Medical Virology  | <b>Course Code:</b> ZOL-668 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> No   |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are to:</p> <ul style="list-style-type: none"> <li>• . To provide expertise in microbiology, with a particular focus on medical virology.</li> <li>• To achieve in-depth knowledge and understanding of medical virology.</li> <li>• Develop an understanding of the scientific basis of concepts, as well as practical skills in medical virology.</li> </ul>  |                             |
| <p><b>Course Outline: Introduction:</b> structure &amp; characteristics: <b>pathogenesis; implantation and portal of entry:</b> local replication and spread; dissemination form portal of entry; incubation period (lytic &amp; lysogenic viruses); shedding of viruses; latent, chronic, slow infections and persistent infections; <b>viral epidemiology:</b> zoonosis; evolution of viruses; nonspecific defenses – anatomical barriers; inhibitors; phagocytosis; viral interference/interferon; immune defenses; immunoprophylaxis – active &amp; passive; sanitation and vector control; <b>chemotherapy:</b> mechanisms, targets, limitations and future of antiviral drugs;</p> |                             |

**clinical manifestations, structure, pathogenesis, epidemiology, mode of transmission, diagnosis and control of a few animal/human viruses** – polio virus; Rubella virus; Lassa virus; influenza viruses; Dengue, encephalitis and yellow fever viruses; rabies virus; mumps virus; measles virus; HIV; hepatitis viruses; Newcastle virus; Ebola virus; sub-acute spongiform virus encephalopathic viruses (mad cow disease) and its human equivalent.

**PRACTICAL:**

1. Laboratory techniques, rules and regulations; ELISA, RIA, techniques; HCV. HBsAg testing kits, HIV kits testing of blood sera;
2. Visitation to hospitals, pharmaceuticals to further enhance knowledge of virology techniques.

**Course Outcomes:**

After studying this course student must be able to:

- Differentiate between the lifecycles of major groups of viruses, in particular how different viruses exploit the molecular and cell biology of their hosts.
- Acquire knowledge of the innate and adaptive defenses of mammals against viruses, and the strategies that viruses have evolved to evade these host defenses.
- Understand strategies to prevent (vaccination) and to treat (antiviral therapy) viral infections.

**Recommended Books:**

1. Murray, P. R., Rosenthal, K., & Pfaller, M. A. Medical Microbiology: Medical Microbiology E-Book (2020). 9<sup>th</sup> edition. Elsevier Health Sciences.
2. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. Medical microbiology (2015). 8<sup>th</sup> edition. Elsevier Health Sciences.
3. Burrell, C. J., Howard, C. R., & Murphy, F. A. Fenner and White's medical virology (2016). 5<sup>th</sup> edition. Academic Press.
4. Flint, S. J., Racaniello, V. R., Rall, G. F., Hatzioannou, T., & Skalka, A. M. Principles of virology,

pathogenesis and control (2020). 5<sup>th</sup> edition. John Wiley & Sons

5. Weitz, J., S. Quantitative viral ecology: dynamics of viruses and their microbial hosts(2016). Princeton University Press.

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|--|-----------------------------|
| <b>Course Title:</b> Faunal Biodiversity of Pakistan   | <b>Course Code:</b> ZOL-669 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> No   |                             |
| <b>Course Objective:</b><br>The course objectives are : <ul style="list-style-type: none"><li>• To enable the student to understand zoogeography of Pakistan.</li><li>• To understand the faunal distribution, its origin across Asia.</li><li>• To know about the threatended and vulnerable species with gaining insight to the marine and fresh water biodiversity of Pakistan.</li></ul>   |                             |
| <b>Course Outline:</b><br><b>Definition:</b> genetics, species, ecosystem, principles of biological richness; <b>paleohistory of Pakistan;</b> present day faunal pattern and species advances of Pakistan. <b>Zoogeography of Pakistan;</b> species of south Asia; original species of Asian origin; species of African origin; bird migration from northern high mountains to Central Asian desert birds; of wetlands; other species including east-west migrants from south; <b>freshwater fish zoo of Pakistan; fauna of eco-zone of Pakistan:</b> Endemic species, species of managerial occurrence; hot spots of species; <b>threatended and vulnerable species; habits and habitats Riparian zones;</b> edge, snags, dead and down woods material; cliffs. Fallen and cover; <b>marine biodiversity.</b><br><br><b>Practicals:</b> <ol style="list-style-type: none"><li>1. Methods and approaches data collection: mammals, birds, reptiles, amphibian, fish.</li><li>2. Invertebrate data analysis: vertebrate, insects and other invertebrates</li></ol> |                             |

3. Collection of ecological data
4. Methods of estimating species richness
5. Population studies and census of wildlife animal.
6. Method of estimating ecological rich areas and hot spots of species.
7. Methods of preparing faunal inventories.

**Course Outcomes:**

After studying this course student must be able to:

- ACQUIRE theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan
- UNDERSTAND the protected area system (Game Reserves, Wildlife Sanctuaries and National Parks)
- SOLVE the threats to wildlife by applying the scientific principles and modern technologies (Sustainable development through local community participation).
- ANALYZE, interpret and synthesize data and other information about the population of wildlife

**Recommended Books:**

1. Cox, C. B., Moore, P. D., & Ladle, R. J. Biogeography: an ecological and evolutionary approach (2016). 9<sup>th</sup> edition. John Wiley & Sons.
2. Liebherr, J. K. (Ed.) Zoogeography of Caribbean insects (2019). Cornell University Press.
3. Heilprin, A. The Geographical and Geological, Distribution of Animals (2015). United States: FB&C Limited.
4. Wallace, A., R. The Geographical Distribution of Animals, Volume 1: With A Study of the Relations of Living and Extinct Faunas as Elucidating the Past Changes Of The Earth's Surface (2018). CreateSpace

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|---|-----------------------------|
| <b>Course Title:</b> Fish Nutrition and Health  | <b>Course Code:</b> ZOL-671 |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours:</b> 3(2+1) |
| <b>Prerequisites:</b> No  |                             |
| <p><b>Course Objective:</b></p> <p>The course objectives are :</p> <ul style="list-style-type: none"> <li>• To provide sufficient knowledge about all physiological phenomena in fishes.</li> <li>• To impart practical information to obtain better growth by following physiological aspects during extensive or semi-intensive culture.</li> <li>• To emphasize thoroughly in breeding of most cultivable freshwater fishes by manipulating reproductive and endocrinological aspects during natural season as well as off seasons.</li> </ul>   |                             |
| <p><b>Course Outline:</b></p> <p><b>Digestive physiology and anatomy of fish:</b> Nutritional biochemistry and metabolism and amino acids, proteins. Fatty acids and lipids, carbohydrates, vitamins and minerals; <b>Nutritional bioenergetics;</b> feed stuff, feed ingredients, unconventional feed ingredients; <b>Storages problems of feed and feed stuff:</b> stability of ingredients in fish feeds, fish feed formulation; <b>Fish feed manufacturing in developing countries with special emphasis on Pakistan;</b> <b>Epizootiology of fish disease:</b> bacterial, viral and fungal diseases of fish and their control; <b>Treatments:</b> therapeutics and disease preventive measures for maintaining healthy fish in aquaculture</p> <p><b>PRACTICAL:</b></p> <ol style="list-style-type: none"> <li>1. Identification and study of phytoplanktons, zooplanktons and algae,</li> <li>2. Identification of fish food and fish feed ingredients.</li> <li>3. Proximate analysis of fish feed ingredients.</li> <li>4. Isolation, Identification and characterization of fish pathogens (parasites, bacteria &amp; fungi).</li> </ol> |                             |
| <p><b>Course Outcomes:</b></p> <p>After studying this course student must be able to:</p> <ol style="list-style-type: none"> <li>1. Relate the key concepts of fish physiology.</li> <li>2. Describe the different systems and their coordination.</li> <li>3. Judge the fish behavior and migration patterns.</li> </ol>   |                             |
| <p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Lee, S., C. Dietary Nutrients, Additives and Fish Health (2015). Wiley</li> </ol>  |                             |

2. Hardy, R., W., & Kaushik, S., J. Fish Nutrition (2021). 4th edition
3. Heath, A. G. Water pollution and fish physiology (2018). 2<sup>nd</sup> edition. CRC press.
4. Wolf, K. Fish viruses and fish viral diseases (2019). Cornell University Press.
5. Dahnze, J., R., & Indulkar, T. Fish Nutrition and Its Relevance to Human Health (2021). CRC Press
6. Maran, B., A., V., & Shaleh, S., R., M. Fish Diet, Health and Control in Aquaculture (2023). Universiti Malaysia Sabah Press

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|---|------------------------------|
| <b>Course Title: Human Genetics</b>   | <b>Course Code: 672</b>      |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3 (2+1)</b> |
| <b>Prerequisites: No</b>  |                              |
| <p><b>Course Objective:</b></p> <p>The objectives of this course are:</p> <ul style="list-style-type: none"> <li>• To understand the terms and basic concepts of genetics, providing a conceptual framework for future reference.</li> <li>• To provide understanding about the continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc.</li> <li>• To develop the concept that continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment</li> </ul>   |                              |
| <p><b>Course Outline:</b></p> <p>Simple autosomal, sex-linked inheritance, lethal genes, chromosomal abnormalities, multiple alleles and blood groups, linkage and crossing over, variation in expression of genes, study of twins as a special method of genetic inference, congenital malformation and prenatal interaction, genetic aspects of race and race mixture. Cancer as a genetic disorder; Gene therapy and its types; inherited immune deficiencies, eugenics; Human Genome Project – in – depth analysis.</p> <p><b>Practical:</b></p> <p>Pedigree analysis, ability to taste PTC, human chromosomes (slides), study of inheritance of some human characteristics, hair color, eye color.</p> |                              |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Define terms of genetics and apply concepts of modern transmission
- Solve transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes.
- Identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored

**Recommended Books:**

1. Turnpenny, P.D., Ellard, S. and Cleaver, R., Emery's Elements of Medical Genetics E-Book. 2020. Elsevier Health Sciences.
2. Strachan T, Read A. Human molecular genetics. 2018. Garland Science.
3. Moore, K.L., Persaud, T.V.N. and Torchia, M.G.,. The developing human-e-book: clinically oriented embryology. 2018. Elsevier Health Sciences.
4. Nussbaum, R., McInnes, R.R. and Willard, H.F., Thompson & Thompson genetics in medicine e-book. 2015. Elsevier Health Sciences.
5. Vogel, F. and Motulsky, A.G., Vogel and motulsky's human genetics: Problems and approaches. 2013. Springer Science & Business Media
6. Kothari, M.L. and Mehta, L.A.,. Essentials Of Human Genetics Fifth Edition. 2013. Universities Press.

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|---|-----------------------------|
| <b>Course Title: Epidemiology of Animal Parasites</b> | <b>Course Code: ZOL-673</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1         | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>                              |                             |
| <b>Course Objective:</b>                              |                             |
| The course objectives are:                            |                             |

- Describe general principles and concepts of animal parasitology
- Classify major animal parasites of animals and humans.
- Describe many of the disease conditions that animal parasite cause and to consider measures that may lead to control of these disease agents.

**Course Outline:**

Animal association, adaptation to parasitism, protozoa, mollusca, arthropoda, acarina, insecta, nematode, acathocephala, trematoda, cestoda, stress. Effect of micro-environment on the parasite distribution in host. Population communities; ecological niche, ecological factors in parasite. Host complex, size relationships. Host age and parasite number, seasonal variations. Movements and hypobiosis: density of population; density dependence; parasite mix; food changes; microenvironments of host. Symbiotic cleaning. Host specificity, action of parasite upon their host.

**Practical:**

- Isolation and separation of parasitic larvae from fecal soil sample.
- Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance.
- Methods of collection, preservation and transportation of parasitic material.
- Identification of insects of medical and veterinary importance.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Assess general principles and concepts of animal parasitology
- Analyze many of the disease conditions that animal parasite cause and to consider measures that may lead to control of these disease agents

**Recommended Books:**

1. Bandyopadhyay, P.K., Das, N.R. and Chattopadhyay, A., Biochemical, Immunological and Epidemiological Analysis of Parasitic Diseases. 2022. Springer.
2. Nag, Vijaya Lakshmi, and Jitu Mani Kalita. "Epidemiology of Parasitic Infections." In Textbook of

Parasitic Zoonoses, 2022. pp. 51-58. Singapore: Springer Nature Singapore,

3. Schmid-Hempel, P., Evolutionary parasitology: the integrated study of infections, immunology, ecology, and genetics. 2021. Oxford University Press.
4. Thrusfield, M., Veterinary epidemiology. 2018. John Wiley & Sons.
5. Mehlhorn H. Animal parasites: diagnosis, treatment, prevention. 2016. Springer.
6. Nelson, K.E. and Williams,. Infectious disease epidemiology: theory and practice. C.M. eds., 2014. Jones & Bartlett Publishers.
7. Sellon, D.C. and Long, M.T. eds., 2013. Equine infectious diseases E-book. Elsevier Health Sciences.

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|---|-----------------------------|
| <b>Course Title: Wildlife of Pakistan</b>   | <b>Course Code: ZOL-674</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>  |                             |
| <b>Course Objective:</b><br>The objectives of this course are: <ul style="list-style-type: none"><li>• To familiarize the students about wildlife diversity of Pakistan</li><li>• To demonstrate how National and International agencies are involved in management of wildlife</li></ul>   |                             |
| <b>Course Outline:</b><br>Wildlife of Pakistan, Introduction, Important Definitions, Identification, Distribution, Status; Biodiversity and sustainability of wildlife; Conservation and Management of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan; Wildlife rules and regulations in Pakistan; National and International agencies involved in conservation and management of wildlife; Protected Areas in Pakistan, Sanctuaries, Game Reserves, National Parks; Ramsar convention, Wetlands, Ramsar Criteria, Ramsar Sites, Threatened species of Pakistan, Vulnerable, Endangered, Critically Endangered<br><br><b>PRACTICAL:</b> <ul style="list-style-type: none"><li>• VISIT to National Parks, Wildlife sanctuaries and game reserves.</li><li>• Population studies of some reptiles, birds and small mammals.</li><li>• Report on endangered species.</li><li>• Demonstration of distribution of animal species of Pakistan (blank maps will be provided)</li></ul> |                             |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire theoretical knowledge about the identification, distribution, status of wildlife in Pakistan
- Analyse , interpret and synthesize data and other information about the population of wildlife
- Demonstrate the ecological assessment and importance of wildlife to certain area.

**Recommended Books:**

1. Aslam, S., Siddiqui, S., Ullah, U., Manzoor, U., Lateef, T., Samreen, N., Nasir, P., Khan, S., Noor, L. and Ghalib, S.A., Vertebrate Wildlife of Pakistan: 2022. A Review.
2. Paul R. Krausman. Wildlife Management and Conservation: Contemporary Principles and Practices. 2<sup>nd</sup> (edi). 2022. Johns Hopkins University Press. Uk.
3. Hunter, L., Carnivores of the world (Vol. 117). 2018. Princeton University Press.
4. Carpenter, J.W. and Marion, C., Exotic animal Formulary-E-book. 2017. Elsevier Health Sciences.
5. Stephen A. Miller and John P. Harley. Zoology. 10<sup>th</sup> (edi). 2016. (International). Singapore: McGraw Hill.
6. West, G., Heard, D. and Caulkett, N. eds., Zoo animal and wildlife immobilization and anesthesia. 2014. John Wiley & Sons.
7. Aghasyan, A., Aghasyan, L., Yeghiasaryan, E. and Amiryan, S., Amphibians and reptiles in the new edition of the Animals' Red Data Book of Armenia. 2013. Agricult. Forestry Fisheries.
8. Mills, L.S., Conservation of wildlife populations: demography, genetics, and management. 2012. John Wiley & Sons.

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|---|-----------------------------|
| <b>Course Title: Quantitative Zoology</b>     | <b>Course Code: ZOL-675</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b> | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>                      |                             |

**Course Objective:**

The objectives of this course are:

- The course will provide knowledge about the importance and use of quantitative data in zoology.
- To help the students to understand the methods to analyse data pertaining to their research work and to assess the significance of their experimental designs.

**Course Outline:**

Introduction; aims and principles of Quantitative Zoology; Techniques used for obtaining quantitative information on morphological, anatomical, ecological and ethological varieties of animal populations; comparison of faunal elements and contemporary approach to classification; handling and interpretation of numerical data, application of statistical techniques used in current zoological research.

**PRACTICAL:**

Construction of phenograms / dendrograms; software programs in quantitative Zoology.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Translate research objectives into clear, testable statistical hypotheses.
- Identify appropriate statistical methods to be applied in each research setting.
- Apply numerical, tabular, and graphical descriptive techniques commonly used to characterize and summarize data.

**Recommended Books:**

1. Kimura, A., Quantitative Biology: A Practical Introduction. 2022. Springer Nature.
2. Michael E. Wall,. Quantitative Biology (Chapman & Hall/CRC Mathematical Biology Series) 1st edition., 2020. CRC Press.
3. Munsky, B., Hlavacek, W.S. and Tsimring, L.S.. Quantitative biology: theory, computational

methods, and models. eds., 2018. MIT Press.

4. Waters, J. and Wittmann, T., Quantitative imaging in cell biology. 2014. Academic Press.
5. Wall, M.E. Quantitative biology: from molecular to cellular systems ed., 2012. CRC Press.

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|--|-----------------------------|
| <b>Course Title: Behavioural Ecology</b>   | <b>Course Code: ZOL-676</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>   |                             |
| <b>Course Objective:</b><br>The objectives of this course are: <ul style="list-style-type: none"><li>• To enable the student to understand not only behavior of animal but combination of behavior and ecology that contribute to reproductive success</li><li>• To understand how animals struggle and survive.</li><li>• To understand difference between survival values on function and those concerned with the casual mechanisms.</li></ul>  |                             |
| <b>Course Outline:</b><br>Animal behavior and Ecology; Introduction, Gene and Behavior, Natural Selection and Behavior Ecology and Evolution, Hypothesis and Testing; Comparative Approach, Adaptations, Social Organization and Experimental Studies, Economic Decisions Made by Individuals, Marginal Value Theorem and Reproductive Decisions, Economics of Prey Choice, Tradeoff and Optimality Models, Competition for Resources in Individuals; Competition by Exploitation, Competition by Resource Defense Merits and Demerits of living in Groups, Fighting Among Individuals; Role of Resource Values and Fighting Ability, Fighting for Dominance, Altruism , Kin Selection, Repository and Manipulation in Animals, Division of Labor and Specialized Helpers.<br><br><b>PRACTICAL:</b> <ul style="list-style-type: none"><li>• Visit to Zoo/Aviary/Peasantry/Breeding-center/Recreational Park/Aquarium to study the behavior</li></ul> |                             |

of animals in different environmental conditions

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire theoretical knowledge of animal behavior, natural selection and evolution.
- Understand the struggle for survival, their ecological relationships
- Solve the survival and breeding related problems which are result of anthropogenic activities.
- Interpretation and synthesis of data and other information about animal behavior, competition and ecological relationships.

**Recommended Books:**

1. Costa, D.P. and McHuron, E.A. Ethology and behavioral ecology of phocids (p. 645). eds., 2022. Cham, Switzerland: Springer.
2. Mech, L.D. and Boitani, L. Wolves: behavior, ecology, and conservation. eds., 2019. University of Chicago Press.
3. Berger-Tal, O. and Saltz, D. Conservation behavior: applying behavioral ecology to wildlife conservation and management eds., 2016. (Vol. 21). Cambridge University Press.
4. Strier, K.B., Primate behavioral ecology. 6<sup>th</sup> ed. 2016. Routledge.
5. Würsig, B., Ethology and behavioral ecology of odontocetes: concluding remarks. 2019. (pp. 483-494). Springer International Publishing.

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|---|-----------------------------|
| <b>Course Title: Ornithology</b>              | <b>Course Code: ZOL-677</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b> | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>                      |                             |

**Course Objective:**

The objectives of this course are:

- To impart knowledge to identify birds and understand their behavior and relationships in their natural habitat.
- To provide vision to understand the factors that cause bird populations to change, and to assess certain bird habitats in relation to climate changes.

**Course Outline:**

Introduction to ornithology; basic ecology and themes of study. Classification and taxonomy of birds up to orders and species evolution of birds; evolution of bird flight, aerodynamics and aerial movements. Bird ancestry; development of feathers, types and their structure; plumage analysis. Biology of fossil birds; study of the representative birds viz. Archaeopteryx, Archaeornithes and Neornithes. Comparison with the present existing birds. Behavioural studies of birds: song and sound dialects in birds; types of songs; preferred season and time for bird pleasure calls; distress calls. Courtship behavior in birds, bird foraging, nesting and roosting activities. Learned and imprinting mechanisms in birds; brood parasitism and importance. Predator-Prey relationships, mobbing impacts; foraging and territoriality scuffles; predator avoidance. Physiology of birds: types of food; mastication; digestion; metabolism, skeletal system; circulatory and nervous system. Role of kidneys in birds. Bird conservation strategies; sanctuaries and importance of urban zoos in bird life.

**PRACTICAL:**

- Identification characteristics and taxonomy of birds to orders and families
- Anatomy of bones, skull, girdles, spine, vertebrae, feathers, plumage
- Study of gut contents of birds to understand feeding habits
- Bird stuffing and preservation of eggs
- Identification of bird species through feathers and egg shells

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire the basic knowledge of the birds in the diversified habitats.
- Understand their behavior and their relationships to the natural habitats.
- Analyze the likely impacts of changing climatic conditions on variety of birds in different ecosystems to sift in roosting, nesting and behavioral mechanisms.

**Recommended Books:**

1. Hauber, M.E., The book of eggs: A life-size guide to the eggs of six hundred of the world's bird species. 2020. University of Chicago Press..
2. Lederer, R.J., The Art of the Bird: The History of Ornithological Art Through Forty Artists. 2019. University of Chicago Press.
3. Reboreda, J.C., Fiorini, V.D. and Tuero, D.T. Behavioral ecology of Neotropical birds. eds., 2019. Cham, Switzerland: Springer.
4. Lovette, I.J. and Fitzpatrick, J.W. Handbook of bird biology. eds., 2016. John Wiley & Sons.
5. Anker, J., Bird books and bird art: an outline of the literary history and iconography of descriptive ornithology. 2014. Springer.

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| <b>Course Title: Mammology</b>   | <b>Course Code: ZOL-678</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b>  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>   |                             |
| <b>Course Objective:</b>   |                             |
| The objectives of this course are:   |                             |
| <ul style="list-style-type: none"> <li>• To impart knowledge to identify mammals and understand their behavior and relationships in their</li> </ul> |                             |

natural habitat.

- To familiarize the students with economic importance of mammalian fauna of Pakistan.

**Course Outline:**

Introduction: what is mammal? Characteristics of mammals. Evolution; The study and history of mammalogy. Classification; Orders of Mammals. Systems; Integument, support and movement. Nutrition; Foods and feeding. Ecology I; Environmental adaptations. Breeding; Reproduction and systems of mammals. Communication I; aggression, and spatial relations. Sexual selection; parental care, and mating systems. Social behavior. Migration and its pattern; Dispersal, habitat selection, and migration. Community Ecology; predation and parasitism, interspecific competition. Skeletal; Structures of the mammalian skull, Teeth, Types of traps used in mammalogy. Echolocations.

**PRACTICAL:**

- Study of common laboratory and zoo mammals
- Identification and classification of local mammalian species
- Study of locomotory adaptations
- Flying mammals and study of bats
- Collection and preservation of small mammals

Identification of mammals through paw patterns. (Skull analysis).

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire the basic knowledge of the distribution of mammals in the diversified habitats.
- Understand their behavior and their relationships to the natural habitats.
- Analyze the scientific and economic importance of mammals

**Recommended Books:**

1. Feldhamer, G. A., Merritt, J. F., Krajewski, C., Rachlow, J. L., & Stewart, K. M. Mammalogy: adaptation, diversity, ecology. 2020. Johns Hopkins University Press.
2. Fleming, T.H., Dávalos, L.M. and AR Mello, Phyllostomid bats: a unique mammalian radiation M. eds., 2020. . University of Chicago Press.
3. Gardner, Mammals of South America, volume 1: marsupials, xenarthrans, shrews, and bats. A. L. (Ed.). 2019. University of Chicago Press.
4. Withers, P.C., Cooper, C.E., Maloney, S.K., Bozinovic, F. and Cruz-Neto, A.P., Ecological and environmental physiology of mammals (Vol. 5). 2016. Oxford University Press
5. Dickerson, E. Mammalogy Class., 2013. Catalog and Field Notes.

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|---|-----------------------------|
| <b>Course Title: Aquaculture and Fisheries</b>  | <b>Course Code: ZOL-679</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>  |                             |
| <b>Course Objective:</b>  |                             |
| The objectives of this course are:  |                             |
| <ul style="list-style-type: none"> <li>• To familiarize students about different aquatic species, their rearing facilities and management by using basic techniques.</li> <li>• To impart knowledge about site selection and construction and management of fish farm.</li> </ul>   |                             |
| <b>Course Outline:</b>  |                             |
| <p>Introduction to fish, fishery and aquaculture, History and present status of aquaculture. Introduction and biology of cultivable fin and shell fishes. Introduction to aquatic resources of Pakistan (Lentic and lotic environment). Fin fish culture: Introduction and role of aquaculture, types of culture systems (Ponds, Raceways, cages, pen, raft and line culture). Site selection, design and construction of fish ponds. Pond problems; aquatic vegetation and their control, fish predators, water quality and management, fish disease and their control. Types of fish feed, characteristics of artificial feed, methods of feeding, types and use of</p> |                             |

fertilizers. Artificial fish breeding techniques. Integrated aquaculture. Shell fish culture: Introduction of shrimp and prawn culture, crabs, lobsters and scallops culture etc. Mari-culture: Substrate system, sea water ponds. Aquaculture in fresh and brackish waters.

**PRACTICAL:**

- Collection and identification of local fishes (fin fish and shell fish).
- Different field visits (Natural and Manmade Reservoirs and Fish Hatcheries) to acquire field knowledge about fish farming.
- Visit to fish hatchery and integrated fish farming.
- Fish feed ingredients and formulation of fish feed
- Artificial Fish breeding

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Identify fish species on the basis of biological characteristics.
- Recognize the problems of fish pond and solve them by using different strategies.
- Acquire knowledge about diagnosis and control of diseases in commercially important fish species.

**Recommended Books:**

1. Dunham, R., Aquaculture and fisheries biotechnology: genetic approaches 2023. . Cabi.
2. Stickney, R.R. and Gatlin III, D.M., Aquaculture: An introductory text. 2022. Cabi.
3. Pandey, P.K. and Parhi, J. Advances in fisheries biotechnology. eds., 2021. Springer.
4. Chen, X. and Zhou, Y. Brief Introduction to Fisheries. eds., 2020. Springer Nature.
5. Lovrich, G. and Thiel, M. eds., Fisheries and Aquaculture: 2020. Volume 9. Oxford University Press, USA.
6. Radhakrishnan, E.V., Phillips, B.F. and Achamveetil, G. Lobsters: Biology, fisheries and aquaculture. eds., 2019. Springer Singapore.

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|--|-----------------------------|
| <b>Course Title: Biotechnology in Aquaculture</b>  | <b>Course Code: ZOL-680</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>   |                             |
| <p><b>Course Objective:</b></p> <p>The objectives of this course are:</p> <ul style="list-style-type: none"> <li>• To equip students with basic and advanced techniques used in fisheries &amp; aquaculture research.</li> <li>• To aware students about the importance of biotechnology in the current era.</li> </ul>  |                             |
| <p><b>Course Outline:</b></p> <p>Introduction; History of Biotechnology in Aquaculture, Biotechnological approaches in Aquaculture, Gynogenesis, Androgenesis and Cloned Populations; Induction of Gynogenesis and Androgenesis<br/>Performance of Gynogens and Androgens, Reproduction, Monosex Populations, Cloned Populations.<br/>Biochemical and Molecular Markers; Isozymes and Enzymes. Restriction Fragment Length Polymorphism, Single Nucleotide Polymorphisms, Relative Costs of Different Markers, Relative Effectiveness of Markers, Gene-transfer Technique in Fish; Promoters, Integration, Transmission of Transgenes, Transgene Expression of Growth-hormone and Reporter Genes, Performance of Transgenic Fish, Disease resistance, Commercial Application of Fish Biotechnology; Polyploidy, Sex Reversal and Breeding, Genetic Engineering, Combining Genetic Enhancement Programmes; Sex Reversal and Triploidy, Genetic Engineering and Crossbreeding, Genetic Engineering, Selection, Crossbreeding, Strains and Hybrids, Food Safety of Transgenic Aquatic Organisms; International Guidelines, Labelling, Environmental Risk of Aquatic Organisms from Genetic Bio technology; Theoretical Risks, Environmental Risk Data on Transgenic Fish, Common Goals of Aquaculture and Genetic Conservation.</p> <p><b>Practical:</b></p> <ul style="list-style-type: none"> <li>• Study of chromosomes and DNA.</li> <li>• Isolation of DNA from fish.</li> <li>• Quantitative analyses of sex hormones.</li> </ul> |                             |

Artificial fecundity and induced breeding of cultivable fish.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Identify and develop insight into the application of biotechnological advances in aquaculture.
- Conceptualize the principal bases of biotechnology and emerging issues in aquaculture.
- Demonstrate various techniques of molecular nature applied for aquaculture development.

**Recommended Books:**

1. Dunham, R., Aquaculture and fisheries biotechnology: genetic approaches. 3rd Edition. 2023. Cabi.
2. Gupta, S.K. and Giri, S.S.. Biotechnological Advances in Aquaculture Health Management. eds., 2021. Springer Singapore, Imprint: Springer.
3. Pandey, P.K. and Parhi, J. Advances in fisheries biotechnology. eds., 2021. Springer.
4. Sundaray, J.K., Rather, M.A., Kumar, S. and Agarwal, D., Recent updates in molecular endocrinology and reproductive physiology of fish. 2021. Springer Singapore.

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|---|-----------------------------|
| <b>Course Title: Limnology</b>  | <b>Course Code: ZOL-681</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>  |                             |
| <b>Course Objective:</b><br>The objectives of this course are: <ul style="list-style-type: none"><li>• To equip students with basic knowledge of limnology its origin and different types</li><li>• To familiar students with the chemical and biological process occurring in the lakes to support aquatic life.</li><li>• To familiar students with the importance and conservation management of lakes problems and management of fish farm.</li></ul> |                             |
| <b>Course Outline:</b>  |                             |

Introduction and scope of Limnology; Introduction, History and scope, Structure of aquatic ecosystems , Origin of lotic and lentic waters, and estuaries, Zonation, Thermal stratification, Eutrophication, Properties of freshwater; Physical properties of water (temperature, light, color, turbidity, conductivity); chemical properties of water (pH, oxygen, CO<sub>2</sub>, salinity, dissolved solids, trace elements, nitrogen, phosphorous and sulphur cycles), Biological properties, plankton (phytoplankton, zooplankton), Methodology for collection , Preservation and identification; Planktonic adaptations and diurnal migration; Factors affecting planktonic productivity, Lake formation; Lake formation and basin morphometry, Processes of Lake Eutrophication, Sedimentation and acidification, Biological productivity in lakes, Lakes of Pakistan, Lakes Conservation and Management.

**PRACTICAL:**

- Survey of lotic and lentic water bodies
- Water analysis of various types of inland water bodies
- Collection, preservation and study of fauna and flora of various water bodies
- Field visit to different Lakes.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire the basic knowledge of physio-chemical properties of lentic and lotic environment.
- Describe thermal stratification, management and conservation of lakes.
- Illustrate the basin morphometry and eutrophication of lakes.

**Recommended Books:**

1. Cole, G.A. and Weihe, P.E., Textbook of limnology. 5<sup>th</sup> Edition. 2015. Waveland Press.
2. Tundisi, J.G. and Tundisi, T.M., Limnology. 2012. CRC Press.
3. Gokce, D. Limnology: Some New Aspects of Inland Water Ecology. ed., 2019. BoD–Books on Demand.
4. Vincent, W.F., Lakes: A very short introduction (Vol. 547). 2018. Oxford University Press.
5. Gharibreza, M. and Ashraf, M.A., Applied limnology. 2014. Springer, Tokyo/Heidelberg/New

York/Dordrecht/London.

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|---|-----------------------------|
| <b>Course Title: Wildlife Ecology</b>   | <b>Course Code: ZOL-682</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b>   | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>  |                             |
| <b>Course Objective:</b><br>The objectives of this course are: <ul style="list-style-type: none"><li>• To elaborate the interaction of wildlife and environment</li><li>• To impart knowledge regarding distribution pattern of wildlife population</li></ul>   |                             |
| <b>Course Outline:</b><br><p>Introduction to wildlife and their relationship with population. Concepts of wildlife conservation, sustainable development and ecosystem. Biomes: Forest, woodland, shrub land, grassland, desert, and marine biomes. Dispersal and distribution patterns. Effect of industrial and agricultural development and Urbanization on wildlife. Predation and its effect on population. Competition within species. Wildlife diseases and their biological control. Exotic wildlife. Endangered species causes and measures for the conservation. International conventions. Problems contributing to risk of extinction.</p> <p><b>PRACTICAL:</b></p> <ul style="list-style-type: none"><li>• Visit to protected areas of Pakistan (Captive, Semi-captive and Wild Areas)</li><li>• Ecological Indices</li><li>• Animal Distribution Maps</li></ul> |                             |

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Demonstrate the ecological assessment and importance of wildlife to certain area.
- Understand basic knowledge of freshwater and marine water ecosystems, their relationship to the physical, chemical, and biological factors of environment

**Recommended Books:**

1. Madliger, C.L., Franklin, C.E., Love, O.P. and Cooke, S.J. Conservation physiology: Applications for wildlife conservation and management. eds., 2020. Oxford University Press, USA
2. Kohler, R.E., Inside Science: Stories from the Field in Human and Animal Science. 2020. University of Chicago Press.
3. Wilson, K., Fenton, A. and Tompkins, D. Wildlife disease ecology: Linking theory to data and application. eds., 2019. Cambridge University Press.
4. Fryxell, J.M., Sinclair, A.R. and Caughley, G., Wildlife ecology, conservation, and management. 2014. John Wiley & Sons.
5. McGarigal, K., Cushman, S.A. and Stafford, S., Multivariate statistics for wildlife and ecology research. 2013. Springer Science & Business Media.

|  |                             |
|--|-----------------------------|
| <b>Course Title: Wildlife Techniques and Data Analysis</b>     | <b>Course Code: ZOL-683</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b>                  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>                                       |                             |
| <b>Course Objective:</b><br>The objectives of this course are: |                             |

- To enable the student to understand values and objectives of wildlife conservation
- To understand the wildlife management rules and regulations in Pakistan

**Course Outline:**

Birds and mammals counting and estimate methods. Counting individual species, counting nesting and flocking birds. Territory mapping techniques. Description and measurements of habitat, habitat analysis and utilization. Capturing methods of animals. Home range measurement. Radio telemetry, density estimates and survival estimation by radio-tracking. Modern techniques for control of environmental pollution in wildlife areas. Processing and presenting data. Measuring average, variability, correlations and regression.

**PRACTICAL:**

- Counting of nests and flock of birds in specific area.
- Population Studies of some Reptiles, Birds and small Mammals.
- Trapping and marking method
- Report on Endangered species

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire basic information regarding data collection in wild animals
- Analyse, interpret and synthesize data and other information about the population of wildlife

**Recommended Books:**

1. Collier, J., Applied structural equation modeling using AMOS: Basic to advanced techniques, 2020. Routledge.
2. Roazen, P., Brother animal: The story of Freud and Tausk. 2020. Routledge
3. McGarigal, K., Cushman, S.A. and Stafford, S., Multivariate statistics for wildlife and ecology research. 2013. Springer Science & Business Media.

4. Wolfensohn, S. and Lloyd, M., Handbook of laboratory animal management and welfare. 2013. John Wiley & Sons.
5. Morrison, M.L., Marcot, B. and Mannan, W., Wildlife-habitat relationships: 2012. concepts and applications.
6. Benson, E., Wired wilderness: Technologies of tracking and the making of modern wildlife. 2010. JHU Press.

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|--|-----------------------------|
| <b>Course Title: Vector Biology</b>  | <b>Course Code: ZOL-684</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>   |                             |
| <p><b>Course Objective:</b></p> <p>The objectives of this course are:</p> <ul style="list-style-type: none"> <li>• To familiarize the students about vectors of medical and veterinary importance</li> <li>• To Know biology, morphology, pathogenesis and life cycle of vectors of medical and veterinary importance</li> </ul>   |                             |
| <p><b>Course Outline:</b></p> <p>Vector Biology and Control; Key aspects of vector taxonomy, Evolution, Biology and Behavior, An introduction to the life-cycles of vectors; Ecology, Role in transmission of various diseases, Major groups of arthropod-borne pathogens and vectors, Basic components of disease cycles, Principles of pathogen transmission dynamics, Emergent pathogens; Vector genetics, vaccines for vector-borne disease, Traditional and modern disease control strategies, Venomous Arthropods, Biology and Ecology of some vectors of medical importance (order Diptera), Mosquitoes (Anopheles culicine), Black flies sand flies, biting midges, horse flies, deer flies and clegs, tsetse flies, house flies, myiasia producing flies (blow flies, blue bottles, green bottles, flesh flies, warable flies and bot flies), Morphology, anatomy, distribution, breeding habits,</p> |                             |

life-cycle and seasonal prevalence of the species, Brief account of diseases spread by these vectors, Methods of control, Modern trends in their biological and chemical control.

**PRACTICAL:**

- Collection, preservation/culture and preparation of slides of local biological and mechanical vectors of medical and veterinary importance and their identification.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire basic information regarding parasites of mammals and birds
- Understand life cycle of vectors and methods to control pests

**Recommended Books:**

1. Guarneri, A. and Lorenzo, M. Triatominae-The biology of chagas disease vectors eds., 2021. Cham: Springer.
2. Qureshi, J.A. and Stansly, P.A. Asian citrus psyllid: Biology, ecology and management of the huanglongbing vector. eds., 2020. CABI.
3. Becker, N., Petrić, D., Zgomba, M., Boase, C., Madon, M.B., Dahl, C. and Kaiser, A., Mosquitoes: identification, ecology and control. 2020. Springer Nature.
4. Harris, K.F. and Maramorosch, K. Aphids as virus vectors. eds., 2014. Elsevier.
5. Crampton, J.M., Beard, C.B. and Louis, C. The molecular biology of insect disease vectors: a methods manual. eds., 2012. Springer Science & Business Media.

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|---|-----------------------------|
| <b>Course Title: Population Genetics</b>      | <b>Course Code: ZOL-685</b> |
| <b>Course Structure: Lectures: 2, Labs: 1</b> | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>                      |                             |
| <b>Course Objective:</b>                      |                             |

The objectives of this course are:

- To know about genetic basis of population
- To understand dynamic nature of population
- To give knowledge of environment role on genetics of a species

**Course Outline:**

Hardy-Weinberg Equilibrium. Frequencies of gene and genotypes. Changes of gene frequency: migration, mutation, selection. Study of small populations: changes of gene frequency under simplified conditions, less simplified conditions, pedigreed population and in breeding; metric characters. Population means, average effects, breeding value, dominance deviation, interaction deviation. Genotypic and environmental variance. Genetic components of variance. Environmental variance. Genetic and statistical background of population genetics, genetic diversity in Mendelian population, random mating, assortative mating, inbreeding, coadaptation, the causes of evolution (random genetic drift, mutation, migration, natural selection, maintenance of genetic polymorphism), polygenic inheritance (artificial selection, heritability, analysis of genetic variation), population genetics and speciation.

**PRACTICAL:**

- Demonstration of Hardy-Weinberg Equilibrium in laboratory populations and natural populations.
- Estimation of inbreeding factors.
- Compartmentation of variance.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Population genetics
- Variation and causes of variation in population
- Role of environment on genetics of a species

**Recommended Books:**

1. Hamilton, M.B., Population genetics. 2021. John Wiley & Sons.
2. Turnpenny, P.D., Ellard, S. and Cleaver, R., Emery's Elements of Medical Genetics E-Book. 2020. Elsevier Health Sciences.
3. Thompson, J.N., The geographic mosaic of coevolution. 2019. University of Chicago Press.
4. Jorde, L.B., Carey, J.C. and Bamshad, M.J., Medical genetics e-Book. 2015. Elsevier Health Sciences.
5. Nussbaum, R., McInnes, R.R. and Willard, H.F., Thompson & Thompson genetics in medicine e-

book. 2015. Elsevier Health Sciences.

6. Ammerman, A.J. and Cavalli-Sforza, L.L., The Neolithic transition and the genetics of populations in Europe (Vol. 836). 2014. Princeton University Press.

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|---|-----------------------------|
| <b>Course Title: Bioremediation</b>           | <b>Course Code: ZOL-686</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1 | <b>Credit Hours: 3</b>      |

**Prerequisites: No**

**Course Objective:**

The purpose of this course is to give knowledge of;

- Bioremediation technology that employs biological agents (microorganisms and plants) to treat hazardous contaminants in soil, and water; can lead to the permanent removal of contaminants from the environment; and may be inexpensive when compared to conventional techniques.

**Course Outline:**

Current remediation practices, benefits of Bioremediation, The soil environment; Fate and transport of contaminants in soils and water bodies Chemical transformations, Microbial ecology and metabolism Biodegradation of common contaminant compounds In situ bioremediation strategies, Solid phase bioremediation, Slurry phase bioremediation and Vapour phase bioremediation, Advantages and disadvantages of bioremediation compared to nonbiological processes. Factors affecting choice of in situ or ex situ processes; bioavailability of pollutant. Biodegradation of specific contaminants (e.g. diesel fuel, polychlorinated biphenyls, dyestuffs, aromatic and polyaromatic hydrocarbons)

**PRACTICAL:**

- Assessment of biodegradability
- Bio stimulation vs bio augmentation
- Mineralization vs. partial degradation

- Factors affecting microbial activity (choice of electron acceptor, toxicity of pollutant, C/N/P ratio, co-substrates, soil humidity, pH and temperature)

### **Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Understand the nature and importance of bioremediation
- Know the influence of site characteristics to bioremediation rates
- Have knowledge of the impacts of contaminant to bioremediation process

### **Recommended Books:**

1. Malik J. A., Advances in Bioremediation and Phytoremediation for Sustainable Soil Management., 2022. Springer International Publishing
2. Iqbal, H.M., Bilal, M. and Nguyen, T.A. Nano-Bioremediation: Fundamentals and Applications. eds., 2021. Elsevier.
3. Hakeem, K.R., Bhat, R.A. and Qadri, H., Bioremediation and biotechnology. 2020. Springer: Cham, Switzerland.
4. Bhat, R.A., Hakeem, K.R. and Al-Saud, N.B.S.. Bioremediation and Biotechnology, Vol 3: eds., 2020. Persistent and Recalcitrant Toxic Substances. Springer Nature.
5. Schlosser, D. Laccases in bioremediation and waste valorisation. ed., 2020. Springer.
6. Prasad, R. and Aranda, E., Approaches in bioremediation. 2018. Springer International Publishing <https://www.springer.com/de/book/9783030023683>.
7. Verma, J.P. and Jaiswal, D.K., Book review: advances in biodegradation and bioremediation of industrial waste. 2016.

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|--|-----------------------------|
| <b>Course Title: Biology and Control of<br/>Vertebrate Pests</b> | <b>Course Code: ZOL-687</b> |
|--|-----------------------------|

|   |                        |
|---|------------------------|
| <b>Course Structure:</b> Lectures: 2, Labs: 1   | <b>Credit Hours: 3</b> |
| <b>Prerequisites: No</b>  |                        |
| <p><b>Course Objective:</b></p> <p>The objectives of this course are:</p> <ul style="list-style-type: none"> <li>• To impart the biology of vertebrate pests</li> <li>• To familiarize the students about the modern concepts of pests and their sustainable management</li> <li>• To impart knowledge about the eco-friendly techniques used in vertebrate pest management</li> </ul>  |                        |
| <p><b>Course Outline:</b></p> <p>Role of vertebrate pests as vectors of zoonotic diseases. Importance of vertebrate pest management. Biology and control of common vertebrate pests in agro-ecosystems of Pakistan. Types of crops inflicted with damage and economic losses by vertebrate pests. Impact of climatic changes on pest 97 efficiencies. Strategic pest management measures: Non-chemical and chemical measures. Pest resistance to chemicals. Estimation methods of damage on crops. Recommended and sustainable management measures in economically important crops for vertebrate pests. Induction of communicable and environmentally hazardous diseases by vertebrate pests and their management.</p> |                        |
| <p><b>Course Outcomes:</b></p> <p>Upon successful completion of this course, the students will be able to:</p> <ul style="list-style-type: none"> <li>• The modern concepts of pests and their sustainable management</li> <li>• The eco-friendly techniques used in vertebrate pest management</li> </ul>  |                        |
| <p><b>Practical:</b></p> <ul style="list-style-type: none"> <li>• Survey of agro-ecosystems to locate their potential burrow/nest systems of various vertebrate</li> <li>• Vertebrate pest damage assessment, collection of samples and preparation of damage reports</li> <li>• Use of some mechanical measures for vertebrate pest control in agro- ecosystems and stored grains</li> </ul>   |                        |

### Recommended Books:

1. Mason, P.G. Biological control: global impacts, challenges and future directions of pest management. ed., 2021. CSIRO PUBLISHING.
2. Jiguet, F., The Fox and the Crow. A need to update pest control strategies. 2020. Biological conservation.
3. Agarwal, M. and Verma, A., Modern technologies for pest control: 2020. a review. Heavy Metals- Their Environmental Impacts and Mitigation.
4. Van Wilgen, B.W., Measey, J., Richardson, D.M., Wilson, J.R. and Zengeya, T.A., Biological Invasions in South Africa. 2020. Springer Nature.
5. Heimpel, G.E. and Mills, N.J., Biological control. 2017. Cambridge University Press.
6. Buckle, A. and Smith, Rodent pests and their control. R. eds., 2015. CABI.



## SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR DEPARTMENT OF ZOOLOGY

The following courses enlisted will be offered for other departments.

| COURSES OFFERED TO OTHER DEPARTMENTS |         |              |
|--------------------------------------|---------|--------------|
| Course Title                         | Credits | Course Codes |
| General Science                      | 3(3+0)  | ZOL-301      |
| Biodiversity of Animal Life          | 3(2+1)  | ZOL-302      |

|                       |        |         |
|-----------------------|--------|---------|
| Essentials of Biology | 3(3+0) | ZOL-401 |
|-----------------------|--------|---------|

|  |                             |
|--|-----------------------------|
| <b>Course Title: General Science</b>   | <b>Course Code: ZOL-301</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 0  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>   |                             |
| <p><b>Course Objective:</b></p> <p>The objectives of this course are:</p> <ul style="list-style-type: none"> <li>• The course covers core concepts in physical science, life science, and earth science.</li> <li>• To study the interdependence of ecosystems and the organisms</li> <li>• To study evolutionary forces to the diversity of ecosystems and of the species within</li> </ul> |                             |

them.

**Course Outline:**

Course Overview; Science in personal and social perspective: The nature of science and scientific investigation (observations, inferences) Teaching of science: reflect upon the way prospective teachers learned science and how they want to teach science when they graduate. Populations and Ecosystems; Basic needs of living things: Interdependencies of living things (symbiotic relationships), Ecosystems and Habitats: Population Growth, survival and Extinction, Populations and Ecosystem, Diversity and Adaptations; Diversity of living things: systems of classification, Adaptations for survival: Evolution and Diversity, Diversity and Adaptation, Earth –The Blue Planet; Earth - an inhabitable planet: Weather and Seasons, Categorizing the world by continents, biomes, vegetation zones, climate zones, etc. Introduction to maps; reading and creating simple data charts, Constant changes on earth: Erosion / sedimentation, Earthquakes and Volcanoes, Force and Motion; Relationship among force, mass, and motion of an object, Interaction of objects as it relates to force and linear, constant motion. Graphing of motion and basic calculations of speed and average speed, Non-linear motion and accelerated motion (Laws of motion), Graphing of nonlinear and accelerated motion, Properties and Matter, Physical properties of matter, including melting point, boiling point, hardness, density, and conductivity, Atoms, molecules, mixtures, elements, and compounds, Introduction to the periodic table, States of matter: solid, liquid, gas (examples of water), Introduction to models and their limitations in science teaching.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Identify the effects of human activities and naturally occurring changes on ecosystems and the consequences of those changes.
- Be able to describe a chemical reaction in the context of a rearrangement of atoms and also in the context of the formation of a new substance with new properties.

- Acquire the knowledge about relationships among force, mass, and motion of an object or system.

**Recommended Books:**

1. Fullick, S. Cambridge Lower Secondary Complete Biology: Student Book. Second Edition. 2021. OUP Oxford.
2. Mukherji. S. Encyclopedia of General Science for General Competitions. 2021. Arihant Publication.
3. Urry, L.A., Campbell, N.A., Campbell biology: 2021. Australian and New Zealand version. Pearson Australia.
4. Callister Jr, W.D. and Rethwisch, D.G., Fundamentals of materials science and engineering: an integrated approach. 2020. John Wiley & Sons.
5. Campbell, N.R., Foundations of science. 2020. BoD–Books on Demand.
6. Fowler, S., Roush, R. and Wise, J. Concepts of biology. ., 2018. OpenStax College, Rice University.

|  |                             |
|--|-----------------------------|
| <b>Course Title: Biodiversity of Animal Life</b>   | <b>Course Code: ZOL-302</b> |
| <b>Course Structure:</b> Lectures: 2, Labs: 1  | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>   |                             |
| <p><b>Course Objective:</b></p> <p>The objectives of the course are:</p> <ul style="list-style-type: none"> <li>· To provide the knowledge of evolutionary/phylogenetic relationship (from simple to the complex organisms).</li> <li>· To impart the basic taxonomic characteristics and classification of all the invertebrate phyla.</li> <li>· To provide understanding of body organization, Feeding and Digestive system; Other Organ System.</li> </ul> |                             |

**Course Outline:**

Classification of animal kingdom, Definition of classification, Major division invertebrates and vertebrates; Classification of invertebrates. Phylum protozoa including general features, classification of Ameoba, Paramecium, Volvox and chlamydomonas. Phylum Porifera; some general features, classification including important species; Sycon, Spongilla, Euplectella, Spongia. Phylum Coelenterates; some general features, Classification including important species; Hydra, Obelia, Physalia, Aurilaurita, Metridium. Phylum Platyhelminthes; some general features, classification including Planaria, Liver fluke and tapeworm. Phylum Aschelminthes; some general features, classification upto orders. Classes; 1. Gastrotricha, 2. Rotifera, 3. Nematoda with examples. Phylum Annelida; general features, classification: Class Polychaeta, Class Oligochaeta, Class Hirudinea. Phylum Mollusca; general features, classification: classes; 1. Amphineura, 2. gastropoda, 3. Pelecypoda, 4. Scaphopoda, 5. Cephalopoda. Phylum Arthropoda: some general features, classification: Class Crustaceans, Class Insecta, Class Chilopoda, Class Diplopoda, Class Arachnids with examples. Phylum Echinodermata (General features; classification).

**Practical:**

1. Study of Ameoba, Paramecium, Volvox and chlamydomonas 2.
2. Study of representatives of classes of Phylum Porifera.
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of phylum Echinodermata.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire the basic concepts of invertebrates with explanation of evolutionary origin and diversification.
- Understand invertebrate organismal concepts in laboratory and field.
- Demonstrate major evolutionary innovations for invertebrates with functional importance.

**Recommended Books:**

1. Schierwater, B. and DeSalle, R., Invertebrate zoology: A tree of life approach. 2021. CRC press.
2. DeSalle, R. and Schierwater, B., Invertebrates And Information. 2021. Invertebrate Zoology: A Tree of Life Approach, p.9.
3. Ray, S., Diarte-Plata, G. and Escamilla-Montes, R. Invertebrates: Ecophysiology and Management. eds., 2020. BoD–Books on Demand.
4. Hickman, C.P., Roberts, L.C/, AND Larson, A., INTEGRATED PRINCIPLES OF ZOOLOGY, 15<sup>th</sup> Edition (International), 2018. Singapore: McGRAW Hill.
5. Pechenik, J.A., BIOLOGY OF INVERTEBRATES, 7<sup>th</sup> Edition, 2015. (International), Singapore: McGraw Hill.
6. Kotpal, R.L., Modern text book of Zoology: Invertebrates. 2012. Rastogi Publications.

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|---|-----------------------------|
| <b>Course Title: Essentials of Biology</b>    | <b>Course Code: ZOL-401</b> |
| <b>Course Structure:</b> Lectures: 3, Labs: 0 | <b>Credit Hours: 3</b>      |
| <b>Prerequisites: No</b>                      |                             |

**Course Objective:**

The objectives of the course are:

- To explain the basic concepts of cell biology
- To understand cellular structure, composition of the organelles, cell growth and cellular division.
- To explain how macromolecules and organelles govern the dynamic organization, function of

living cells.

**Course Outline:**

Biology and its major fields of specialization, The Cell:; Emergency and Implication of Cell Theory, Organelles of cell. Biological Molecules: Protein, carbohydrates, lipids and nucleic acids i.e DNA and RNA, Mechanism of Enzymes action and factors affecting enzymatic activity. Chromosomes and DNA: Types and composition of chromosomes, Chemical nature of DNA and gene, DNA duplication, Transcription and translation (protein synthesis), Mutation. Cell Cycle and Cell division: Mitosis and Meiosis, Variation and Genetics, definition of Alleles, Gene pool, Law of segregation, Law of independent Assortment and sex Determination. Bioenergetics: Difference Between Photosynthesis and Respiration, Light and Dark Reactions Aerobic and anaerobic Respiration and glycolysis, Kreb's Cycle and Electron Transport Chain. Biotechnology: Gene cloning, Analyzing DNA (polymerase chain reaction) and biotechnology products, Gene therapy and gene culture. Variety of life: General Characteristics of: Kingdom Prokaryota, Kingdom Protista, kingdom Fungi, Kingdom Plantae, Kingdom Animalia. The concept of Homeostasis: Osmoregulation in plants and animals, Excretion in animals, Thermoregulation in animal, Growth and Development in plants and animals, Reproduction in plants and animals, Plant Movements and Plant Hormones, Coordination in Animals. Evolution: Evolution and its theories, Speciation. Ecosystem and energy flow: Major ecosystems, Biochemical cycles, Man and his environment, Renewable and non-renewable resources, Degradation and Depletion of resources, Global Warming and Conservation biology.

**Course Outcomes:**

Upon successful completion of this course, the students will be able to:

- Acquire the basic knowledge of levels of organization in life
- Understand the metabolic processes of cells in terms of cellular organelles, membranes, and biological molecules.

- Ability to understand the role of macromolecules regulating cellular processes.

#### **Recommended Books:**

1. Hunter, G.W., 2023. Essentials of biology presented in problems. BoD–Books on Demand.
2. Pollard, T.D., Earnshaw, W.C., Lippincott-Schwartz, J. and Johnson, G. Cell biology, 2022. E-book. Elsevier Health Sciences.
3. Mader, S.S., Windelspecht, M. and Cox, D., Essentials of biology. 6<sup>th</sup> Edition. 2021. McGraw-Hill higher education.
4. Slack, J.M. and Dale, L. Essential developmental biology. , 2021. John Wiley & Sons.
5. Gunn, A. Essential forensic biology. 2019. John Wiley & Sons.
6. Alberts, B., Bray, D., Hopkin, K., Johnson, A.D., Lewis, J., Raff, M., Roberts, K. and Walter, P., Essential cell biology. 2015. Garland Science.
7. Hoefnagels, M., Biology concepts and investigations. 2015. Energy.

**Course Outline: Spectroscopy:** UV Spectroscopy/Separations, Quantitative Infrared Spectroscopy, Flame Atomic Absorption Spectroscopy, Direct Potentiometry; **Spectrofluorimetry:** Determination of Fluid Volumes by Dye Dilution Techniques; **Chromatography:** Thin Layer Chromatography (TLC), Gas Chromatography, High Performance Liquid Chromatography (HPLC). Drug Monitoring Techniques, Column Techniques: Separation of Transition Metal Cations; **Spectrometry:** Principles of IR-spectrometry and its use for compound identification; understanding of the working mechanism of the basic components of spectrometric and mass-spectrometric instrumentation; **Molecular Techniques:** Amino acid sequencers, Balances, Bioreactors, Blotting Apparatus, Centrifuges, DNA Sequencers, Electroporation Instrument, Electrophoresis, Isoelectric Focusing Apparatus, Lyophilizer, Microarray Technology. **Principles and application of Microscopy;** Microtomy; Nuclear Magnetic Resonance Instrument, Geographic Information Systems and Remote sensing, ELISA, Cell culture.

**Course Outcomes:**

After studying this course student must be able to:

- Understand advanced biological techniques
- Apply practical and research skills
- Operate and use the lab equipment efficiently.

**Recommended Books:**

6. Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Brooks Cole. Principles of Instrumental Analysis, 7th edition 2017, Cengage Learning.
7. Skoog, Douglas A., Holler, F. James., Crouch, Stanley R.. Custom Pub: Principles of Instrumental Analysis. 2013, Canada: Nelson Education Limited, .
8. Francis Rouessac and Annick Rouessac, Chemical Analysis: Modern instrumentation, methods and techniques, 2000,,John Wiley & Sons.
9. Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Principles of Instrumental Analysis (5th ed), 1997,, Brooks Cole.
10. Spectrometrischeanalysetechnieken, M.T.C. de Loos - Vollebregt, Heron reeks - Bohn Stafleu Van Loghum, 2004, ISBN 90-313-4142-8.
11. Rouessac, F. and Rouessac, A. Chemical Analysis: Modern instrumentation, methods and techniques, 2000,John Wiley & Sons.